This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

ASTRONOMY

WITH THE NAKED EYE

GARRETT P. SERVISS

Astr 8193.2.11

HARVARD COLLEGE
LIBRARY

GIFT OF

EDWIN FRANCIS GAY

PROFESSOR OF ECONOMICS

SCIENCE CENTER LIBRARY

140
802

12/11

ASTRONOMY

WITH THE NAKED EYE

A NEW GEOGRAPHY OF THE HEAVENS

WITH DESCRIPTIONS AND CHARTS OF CONSTELLATIONS, STARS, AND PLANETS

BY

GARRETT P. SERVISS

AUTHOR OF

"ASTRONOMY WITH AN OPERA-GLASS"

NEW YORK AND LONDON

HARPER & BROTHERS PUBLISHERS

Astr 8193.2.11

HARVARD COLLEGE LIBRARY
GIFT OF
EDWIN FRANCIS GAY
Aug 30, 1932

PRESERVATION MASTER
AT HARVARD

Copyright, 1908, by HARPER & BROTHERS.

TO

GARRETT P. SERVISS, JR.

UNTIMELY DEAD AT ITHACA, N. Y.

DECEMBER 28, 1907

CONTENTS

I

THE PLEASURE OF KNOWING THE CONSTELLATIONS

The stars as landmarks—Effect of going north or south on the appearance of the heavens—Personal influence of the stars—Viewing the constellations amid historic scenes—Cassiopeia seen from Clytemnestra's tomb—The celestial pageant from Mount Etna—The stars announce the seasons—Atmospheric influence on the appearance of the stars—Individuality of the stars—Star magnitudes—Star colors—The charm of star groupings—The harmony of the spheres—How scientific astronomy has drifted out of popularity . . . . . Page 1

II

CONSTELLATIONS ON THE MERIDIAN IN JANUARY

Definition of the meridian—The double revolution of the heavens—Auriga, the charioteer—Capella and its history—Camelopardalis—Taurus, the Bull—Aldebaran—The Hyades—The Pleiades—Worship of and superstition about the Pleiades—Orion, the most brilliant constellation—Betelgeuse—Rigel—The Belt Stars—Bellatrix—The Great Nebula—Story of Orion—Telescopic riches—Eridanus—Great length of the constellation—Its story—Telescopic stars—Lepus, the Hare—Its conspicuous situation—Its origin—A wonderful red star—Columba the Dove . . . . . Page 16

III

CONSTELLATIONS ON THE MERIDIAN IN FEBRUARY

Canis Major, the Greater Dog—Sirius—Why called the Dog Star—Legends and superstitions about Sirius—Its strange com-

panion — Monoceros — Canis Minor — Procyon — Gemini, the Twins, the fourth constellation of the zodiac — Castor and Pollux — Their history — Why called the sailors' stars — Lynx . . . . . Page 42

IV

CONSTELLATIONS ON THE MERIDIAN IN MARCH

Cancer, the Crab, the fifth constellation of the zodiac—The Manger, or Præsepe—Ancient importance as a weather sign—Galileo's discovery—Planetary conjunctions in Cancer—Hydra, one of the largest of the constellations—Superstitions concerning it . . . . . Page 57

V

CONSTELLATIONS ON THE MERIDIAN IN APRIL

Leo, the Lion, sixth of the zodiacal set—The figure of the Sickle—The famous star Regulus—This constellation always represented as a lion—Leo Minor—Ursa Major, the Greater Bear—The celebrated figure of the Great Dipper—Its various names—The names of its seven stars—Mizar and Alcor—Sextans—Crater, the Cup . . . . . Page 65

VI

CONSTELLATIONS ON THE MERIDIAN IN MAY

Corvus, the Crow—Virgo, the seventh constellation of the zodiac—The beautiful Spica—A mine of myths—The field of the Nebulæ — Coma Berenices—The legend of a queen's hair — Lilac stars—Canes Venatici, the Hunting Dogs—The beautiful Cor Caroli . . . . . Page 77

VII

CONSTELLATIONS ON THE MERIDIAN IN JUNE

Libra, the Balance, eighth in the zodiacal circle—A green star—Boötes, the great constellation of the north—Arcturus and its

great fame—Corona Borealis—Beautiful form of the constellation—The Pearl of the Crown—Ursa Minor, the polar constellation—The star Polaris—Draco, the great dragon of the north—Alpha Draconis, formerly the pole star—Relation of the Great Pyramid to this star—History of Gamma Draconis . Page 87

VIII

CONSTELLATIONS ON THE MERIDIAN IN JULY

Scorpio, ninth zodiacal constellation—Conspicuous figure of the scorpion—The great red star Antares—Its wonderful green companion—Ophiuchus and Serpens—Hercules, the constellation towards which the earth is travelling—Mystic significance of this constellation in ancient times . . . . . Page 102

IX

CONSTELLATIONS ON THE MERIDIAN IN AUGUST

Sagittarius, the Archer, tenth constellation of the zodiac—Beauty of the Milky Way in Sagittarius—Scutum Sobieskii and its star clouds—Aquila, the Eagle—The star Altair—The curious Chinese legend of the Spinning Damsel and the Magpie Bridge—Sagitta—Lyra, the Harp of Orpheus—Singular splendor of the star Vega—When it will be the pole star again . . Page 112

X

CONSTELLATIONS ON THE MERIDIAN IN SEPTEMBER

Capricornus, the Goat, eleventh of the zodiacal circle—The Gate of the Gods—Delphinus, the Dolphin—The fable of Arion—Equuleus—Vulpecula—Lord Rosse's wonderful Dumb-bell Nebula—Cygnus, the Swan—The Northern Cross—Beauty of Albireo—61 Cygni . . . . . Page 122

XI

CONSTELLATIONS ON THE MERIDIAN IN OCTOBER

Aquarius, the Water-bearer, the last in the zodiacal circle—Piscis Australis, the Southern Fish—The star Fomalhaut—Pegasus,

the Winged Horse—The Great Square of Pegasus—Legends of the Winged Horse—Lacerta—Cepheus, the King—The Royal Family of the sky . . . . . Page 130

XII

CONSTELLATIONS ON THE MERIDIAN IN NOVEMBER

Pisces, the Fishes, leader of the zodiac—The Greenwich of the sky—Planetary conjunctions in Pisces—Andromeda, the constellation of romance—The great Andromeda nebula—Story of Andromeda and her rescuer, Perseus—Cassiopeia, the Queen—The "W," or Key—Tycho Brahe's star . . . Page 138

XIII

CONSTELLATIONS ON THE MERIDIAN IN DECEMBER

Aries, the Ram, leader of the zodiacal signs—Antiquity of the constellation—Triangulum—Perseus, the conqueror of the Gorgon—The Gorgon star Alcor—The new star of 1901—Cetus, the Whale—The wonderful variable Mira . . . Page 148

XIV

THE SOUTHERN CONSTELLATIONS

Argo Navis—The great star Canopus—The South Pole—The Southern Cross—Centaurus—Alpha Centauri, the nearest star—Ara, the Altar—The Triangle—Grus and Toucan—The Phœnix—The Southern Eridanus—The star Achernar—The Magellanic clouds . . . . . Page 158

XV

THE MILKY WAY

Ancient ideas of the Milky Way—The pathway of the gods and of spirits—The story of Phaeton—The Milky Way figured as a river—Course of the Milky Way through the sky—Great stars that follow the Milky Way—The Coal Sack—Mythology of the Milky Way . . . . . Page 171

CONTENTS

XVI

THE ZODIACAL LIGHT

Its appearance and the seasons when best seen—Traced across the whole sky—Du Chaillu's description—Humboldt's description—Scientific theories of the Zodiacal Light . . Page 182

XVII

THE PLANETS

How they differ in appearance from stars—Their motions—Five only known to the ancients—Superstitions about them—The first discoveries—Mercury, Venus, Mars, Jupiter, and Saturn; their peculiarities, their sizes, distances, movements, rotations, surface characteristics, and their condition from the point of view of habitability . . . . . Page 186

XVIII

THE MOON

Fascination exercised by the moon—The strange spots on her surface—Stories of the Man in the Moon—Stories of the Woman in the Moon—The Hare in the Moon—Galileo's discoveries—Nature of the lunar surface—The birth of the moon from the earth—The question of habitability—Eclipses, their scientific importance, their popular interest, and the superstitions associated with them—Earthlight on the moon—The moon and the months—Occultations by the moon . . . . . Page 226

INDEX . . . . . Page 243

LIST OF CHARTS

CHART I.	*Facing page*		16
CHART II.	"	"	42
CHART III.	"	"	58
CHART IV.	"	"	66
CHART V.	"	"	78
CHART VI.	"	"	88
CHART VII.	"	"	102
CHART VIII.	"	"	112
CHART IX.	"	"	122
CHART X.	"	"	130
CHART XI.	"	"	138
CHART XII.	"	"	148
CHART XIII.	"	"	158
CHART XIV.	"	"	226

PREFACE

THE specific things undertaken in this book are: First, the presentation of a set of star-charts, accompanying and illustrating the text, and containing the *constellation figures*, so that the reader may see those strange forms that the imaginations of men for thousands of years have drawn in the sky. The charts also contain all the stars that have received distinctive names, and with these all the other stars that the unaided eye readily perceives. The sixth-magnitude stars are *visible* to ordinarily good eyes, but they are inconspicuous. The charts are reductions from Heis's *Atlas Cœlestis*.

A chart of the southern sky has been added to cover the constellations not visible from our latitudes.

Second, the march of the constellations across the sky, resulting from the annual revolution of the earth in its orbit, is followed from month to month, and they are presented in the text according to the times of their successive arrivals near the meridian, the north and south line of the sky. Of course they are not visible only when on or near the meridian; but some system must be followed in describing them, and this arrangement, recognizing the sequence of the months, and presenting them when, upon the whole, they are best placed for observation, seemed prefer-

able to any other. The appearance of the constellations, as viewed with the naked eye, is described, their histories and mythologies are given, and the stories of their chief stars and star groups are detailed. For the convenience of those who have telescopes, some of the double stars and other interesting telescopic objects in each constellation are described and their positions indicated.

Third, the planets are described in a separate chapter, with illustrations intended to enable the uninitiated reader to follow their paths among the stars and to predict their approximate places for himself. In consequence of their constant motion, the planets cannot be indicated by symbols definitely located on the charts like the fixed stars.

To sum up, the general purpose is to revive and cultivate interest in the picturesque and easily understood side of astronomy, so that everybody who wishes may "feel at home in the starry heavens," may share in the great intellectual pleasures which an acquaintance with them invariably gives, and may understand and enjoy the references to the stars, the constellations, and the planets that abound in all literatures and in all the periodicals of the day.

GARRETT P. SERVISS.

BOROUGH OF BROOKLYN, NEW YORK,
March, 1908.

ASTRONOMY
WITH THE NAKED EYE

ASTRONOMY WITH THE NAKED EYE

I

THE PLEASURE OF KNOWING THE CONSTELLATIONS

"If the stars should appear one night in a thousand years, how would men believe and adore and preserve for many generations the remembrance of the city of God which had been shown?"

—RALPH WALDO EMERSON.

THE stars are the true landmarks which are never changed. Because of their infinite distance they are always at hand, for no shifting of our place upon the tiny earth can sensibly alter their position. If, when we travel into strange lands, the familiar stars vanished and new ones took their place, our feeling of remoteness from home would become unbearable. We should lose confidence in ourselves. It was the friendly stars that first led men round the globe. As long as those well-known sentinels shone, tranquil and steadfast overhead, they had courage to go on and on. If the stars had deserted him, even Columbus would have lost heart. Because when we

cross the equator and travel into the southern hemisphere some of the constellations do sink permanently below the horizon, while unfamiliar ones rise in the opposite quarter, a journey in that direction seems longer than others. Nothing astonished the early navigators more than the unusual aspect of the austral firmament, and in particular the splendor of the Magellanic clouds and the Southern Cross, which seemed to them symbolic of an unknown world. The renown that these constellations attained in the days of the first circumnavigators still kindles the imagination.

So, in the far north the strange aspect of the nocturnal sky and the displacement of the arctic constellations agitate the most undaunted spirits as much as does the extraordinary character of the landscapes. The man who stands upon the pole of the earth, as somebody will do some day, will behold nothing so fantastically wonderful as the horizontal motion of the heavens, carrying the stars in circles of perpetual apparition, and swinging the sun and the moon round the whole horizon as if suspended by invisible chains from the vortex of the world.

In the experiences and sentiments of individual life the stars play a great part. Many a lonely night, with all terrestrial friends far away, has been brightened for me by the fraternal presence of Orion or Böötes. Amid the solitude of a hunter's camp, with companions absent on a night-long expedition, and the watch-fire languishing, it has been an inexpressible comfort to see through the lofty tops of the trees familiar constellations flashing recognition and

giving assurance of their unfailing nearness. Aratus, the Greek singer of the stars, clearly expressed a personal experience when he wrote that "from all quarters heaven *speaks* to man." Make the acquaintance of Polaris, Sirius, Arcturus, Regulus, Vega, Spica, Rigel, and they will be always with you on your mundane way, never leaving you alone and unfriended. He who knows the stars and constellations carries the map of the world in his head. He has a book older than Homer always open before him. He is in a gallery of pictures containing the masterpieces of the human imagination when the world was young and thought untrammelled.

The mere names of the ancient constellations captivate the mind. Who can look unmoved upon Andromeda, chained, and Perseus, with diamond sword, speeding to her rescue; or upon Orion, lifting his starry club to meet the Bull, charging headlong down the curve of the zodiac? It is a felicity to know Sirius, that great prismatic star that awed the ancient land of the Nile at his rising, and in whose honor immense temples, the oldest in the world, were erected; or Arcturus, whose power and beauty inspired the poet Job.

Among the tableaux of memory that I should most grieve to lose are views of the picturesque heavens disclosed amid remarkable scenes in foreign lands. I would instance a vision of Cassiopeia, seen shortly before dawn on an August morning through the broken roof of the huge vaulted sepulchre at Mycenæ, called Clytemnestra's tomb. I had ridden through a moonlit night from Corinth, over the mountain-

ous neck of the Peloponnesus, and down to the head of the Valley of Argolis, and had arrived at the ruins of Agamemnon's capital just as the moon set, at the darkest hour of the night. Amid the gloom, fighting off the awakened dogs, I set out with my guide to explore the half-disinterred city. After we had viewed the bat-inhabited interior of the so-called Treasury of Atreus by the light of a brush-fire, we approached the smaller "beehive tomb" of Clytemnestra, near the Gate of the Lions. Stumbling over fallen stones, I found myself in the empty chamber where the body of the royal murderess is said to have lain three thousand years ago, and, glancing upward, was startled at the sight of Cassiopeia, flashing down through the shattered dome from her throne of stars. Near her shone her daughter Andromeda, and Perseus, the slayer of the Medusa and the Sea Dragon. From the underground gloom that enveloped us the spectacle was more magnificent than I can picture it in words. But its greatest power lay in suggestion, for who could help remembering the legend that those starry characters had had their birth in this very valley, and had founded Mycenæ, long anterior to the days of Clytemnestra and Helen, Agamemnon and Hector? Cassiopeia had probably found her place in the stars, and been recognized there, before Homer's songs were sung. To know the constellations is better than to know the Iliad—and easier.

Another instance of the exquisite pleasure that acquaintance with the constellations is capable of adding to the enjoyment of impressive and historic

scenes recurs with the recollection of a view of the starry heavens which I once had from the unobstructed summit of Mount Etna, which, having no rival within the entire range of vision, puts a circle eight hundred miles in circumference under the observer's eyes, while lifting him on its lone pinnacle into the midst of the sky. Three or four hours after midnight, at the time of the Autumnal Equinox, I stood on the verge of the great crater, and after a shuddering glance at the fiery spiracles of the volcano, deep in its throat, turned to look off. The darkness over the world below seemed fathomless, except where the lights of Catania lay sparkling tremulously, as if a living constellation had fallen there and sunk to the bottom of the aerial ocean. For an instant I quailed at the sight of the smooth, jet-black slopes of the cone, gliding, terrifically steep, down into the gloom until, like shadows, they vanished; but the glory of the surrounding heavens soon blended all sensations into that of sublimity alone.

Beyond the Gulf of Erebus, in the direction of the Strait of Messina, where modern guide-books show the seats of Scylla and Charybdis, and above the dimly visible mountains of Calabria, rose a refulgent procession. First, the starry prow of Argo, Jason's ship, in which he chased the Golden Fleece; then Canis Major, with blinding Sirius in his jaws; then Orion, magnificent with his jewels as I had never beheld him; Eridanus, winding in streams of golden stars; and Taurus, ablaze with the splendor of the Hyades and the Pleiades. Parallel with this train of celestial pageants was stretched the lustrous scarf

of the Galaxy, and from another point on the horizon towered the Zodiacal Light, a gleaming portent, with Jupiter glowing calm and steady at its apex, as if Zeus on Olympus were presiding again over the gods and heroes. The whole sky was a pictured scroll of Greek mythology, while the land beneath it was "more Greek than Greece itself"—the land of Theocritus, Amaryllis, Persephone, Lacon, Daphnis, Empedocles. Yonder, just under the coils of the celestial Hydra, was the slope where the heedless companions of Ulysses hunted the oxen of the sun, and I knew that when daylight came I should perceive, just at the edge of the sea there, the black rocks that Polyphemus is said to have hurled after the escaping ship of the cunning hero who had blinded him. Towards the south, with Jason's ship glittering above it, lay ancient Syracuse, with Arethusa's magic fountain, and the reedy home of Cyane. Southwest, under the star-shod feet of Pegasus, was the sacred hill of Enna, and the necromantic lake where Aidoneus carried off Persephone to the underworld, until Demeter found and rescued her. Thus the memories that rose in crowds from the storied land hidden below, answering to the emblazoned legends written with starry fires overhead, afforded an hour of romantic contemplation without a parallel in my experience.

It is no small part of the charm and interest of the constellations that they announce and prefigure the seasons. Spring, summer, autumn, and winter—each has its characteristic stars, which keep step with the year. When the early snows whiten the

hills in December comes, with the jingling of sleigh-bells, Orion. Who would not wish to know him as he climbs the eastern sky, scintillant with star-gems, darting vivid sparks of varied color that affect the eye as the bells do the ear? The coruscating landscape and the spangled firmament are in accord. Orion, in a listless summer night, when the face of the earth is dark and still, and the starlight falls without a ripple in the languid air, would be deprived of half his splendor. Orion, declining to the west in a spring evening when the snows are gone, the trees have begun to feel the sap, and the misty atmosphere is drowsy with the aroma of the awakening earth, is a dethroned monarch. The mighty star fields surrounding him are then like the scenes of a theatre after pallid dawn steals in upon them.

But the charm of the heavens does not cease at the advent of spring—the wand passes to another set of constellations. The vernal sky has its own enchantment. As the earth puts on its earliest verdure the mild light of Virgo appears in the east, and silvery Spica beams in placid rivalry with the gold-orange radiance of Arcturus hanging below the great handle of the Dipper, between the sheen of Berenice's Hair and the linked pearls of the Northern Crown. The constellations that rise at the opening of the year, instead of the ostentation and magnificence displayed in the hiemal sky, possess a quiet beauty that harmonizes with the season. When, in an April or May night, the sedate Virgin glows amid her well-ordered stars, like an abbess surrounded by white-veiled nuns, how exquisitely the celestial mood re-

sponds to the brooding planet! No one who has not had the experience can imagine, or fully credit, the thrill of pleasure that comes to the lover of the stars with his earliest glimpse of the constellations that announce the morning of the year. It is a joy deeper than that felt by the discoverer of the first rhodora in the woods. Those constellations are as much a part of the season and as prophetic of its delights as are the scented air and the pied meadows.

And with summer arrives yet another empyreal pageant as gorgeous as that which then decks the teeming surface of the globe. Scorpio, sprawling over the horizon, with fire-red Antares flaring on his carapace, seems to burn with ardent reflection of the torrid sunset. The Crown hangs lambent in the zenith, and, festooned across the orient sky, like sheets of summer lightning arrested and motionless, hangs the Milky Way. Vega, as pure a diamond as the sky contains, glows among the silver-gemmed strings of the Lyre, while the centaur, Sagittarius, lazily draws his arrow to the head and takes his never-ending aim, where the Galaxy spreads brightest above the southern verge of the sleeping earth.

Then on comes winter once again, and the snorting blasts of December are not more characteristic of the boreal season than is the return of those constellations whose distinguishing feature is the keen brilliance of their stars, startling and piercing the eye with incessant darts. The quality of the sidereal radiations is now different. Aldebaran in Taurus is red, and so is Antares in Scorpio, but the redness of Aldebaran is that of a polished gem, while the redness

of Antares is the soft color of flame. The cause of the difference is no doubt largely atmospheric, and allied to that which produces the distinctive textures of summer and winter clouds. The mien of Orion and his glittering attendants is essentially spectacular. The aspect of this assemblage of epauletted constellations recalls a fanfare of trumpets. They are so showy and restless in their multitudinous flickerings, and have such an appearance of carrying the celestial battlements with a rush, that one almost fancies a shout from the sky!

The individuality, and perhaps I may say the personal peculiarities, of the stars, are sources of endless pleasure for those who study them. The science of stellar photometry divides the stars visible to the naked eye into six magnitudes, or orders of brightness. But these are arbitrary, and the actual gradations are innumerable. Perhaps it would be as difficult to find two stars precisely alike as to find exact counterparts among the faces in a crowd. This is particularly true of the conspicuous stars which the eye sees without any effort of looking. No two ranked as of the first magnitude are equal, and the inequality in some cases is very great. Sirius, the indisputable leader of the whole stellar host, is ten or twelve times brighter than either Fomalhaut or Deneb Cygni, yet both of these are generally called first-magnitude stars. In fact, the first-magnitude stars, to which dignity the most indulgent estimate can admit but twenty in the entire firmament, constitute a kind of sidereal peerage whose members exhibit as much variation in splendor and impres-

siveness as do the princes, dukes, marquises, and earls of a terrestrial nobility. Indeed, according to the more strict photometry developed in the closing decade of the nineteenth century, there are *eight* star magnitudes embraced within the range of the naked eye, two grades having been added above the old first magnitude. The highest, or brightest, is the *negative first magnitude*. Then comes the *zero* magnitude, and below that follow, in order, the former first, second, third, fourth, fifth, and sixth magnitudes. Between one magnitude and its next neighbor the increase, or decrease, of brightness is approximately two-and-a-half times (accurately, 2.512)—*i. e.*, a star of the first magnitude is two-and-a-half times as bright as one of the second magnitude, six-and-a-quarter times as bright as one of the third magnitude ($2.5 \times 2.5 = 6.25$), and so on, a sixth-magnitude star having only one-one-hundredth as much light as a first-magnitude one. Standards of the first magnitude are Aldebaran and Altair. The zero magnitude is two-and-a-half times as bright as the first magnitude. Arcturus is a representative of this rank. The negative first magnitude, two-and-a-half times brighter yet, has but one member, the princely Sirius, and he even exceeds the ideal standard of his own rank, his actual magnitude being -1.4. The actual brilliance of Sirius exceeds that of a standard first-magnitude star about nine times. Next to Sirius in brightness is Canopus, in the Southern Hemisphere, invisible from most of the United States. According to some estimates, Canopus should be admitted to the negative first magnitude, but he

would occupy a place in that order far below Sirius.

But it is not only in brightness that the stars differ one from another. Their variations in color are only less striking. Even those that are called white show surprising chromatic variations. Both Vega and Sirius are reckoned as white, but the former has a distinct tinge of blue and the latter a shade of green. Rigel is also a blue-white star, but the intermixture of azure is less pronounced than in Vega. Procyon is white of a yellowish tinge, Capella is creamy white, and Spica silvery. On the other hand, Arcturus, Betelgeuse, Aldebaran, and Antares are all spoken of as red, or ruddy, yet the first is yellowish-red (in some states of the air simply light yellow), the second is topaz-hued, the third is a light rose, and the fourth is the color of fire. The atmosphere has much to do with the color and aspect of the stars. Faint stars are best seen near the zenith, where their light suffers the least absorption. Very bright stars, on the contrary, often seem most brilliant when near the horizon, where, although they are robbed of half their light, their rays play with amazing vivacity, and dart prismatic flashes. Prosper Henry pointed out the fact that when a star close to the horizon is viewed with a telescope its image, instead of being a point, appears in the form of a little vertical spectrum, or band of prismatic colors, the red, as the least refrangible, being at the top.

Then there is a wonderful charm in the grouping of the stars, and this gave rise to the invention of the

constellations. In their assemblages they set off and heighten one another's attractions. Anybody can verify the truth of Xavier de Maistre's remark that when one fixes his eyes on a particular star all of its neighbors seem to scintillate more vividly, as if to divert his attention to them. The shapes of many constellations give a geometrical enjoyment to the eye. The suggestion of some law of connection among their stars also sets the imagination at work. The impression thus produced recalls what Humboldt says of the singular mental influence of the forms of such lands as Italy, Sicily, and Greece, and of such bodies of water as the Black and Caspian seas. The Belt of Orion, with its surprising straightness and the notable equality of its stars, which resemble carefully matched gems set on a bar, produces an ineffaceable impression which seems as wonderful the hundredth time of viewing as the first. Even the most uncultivated minds are affected by the air of comradeship which some star groups exhibit. Thus the Rev. W. M. Beauchamp relates that the Onondaga Indians have a story that the Pleiades are a group of merry children who once, with shouting and laughter, danced away into the sky, and could never find their way back to the earth. Scorpio, with its curiously curved lines of stars, arrests everybody's attention, and with its look of crawling along just on the verge of the horizon, it gives an uncanny feeling, for there is hardly another constellation whose appearance so completely corresponds with its name.

Regarded in their broader relations and contrasts,

the stars as a whole possess a marvellous harmony of effect. It is the true music of the spheres, for who shall say that the universally felt influence of the star-bedight heavens does not arise from our instinctive, but as yet uneducated, perception of a concord which is not of "sweet sounds," but of light and color, whose range of vibrations in the ether infinitely exceeds that of sonant oscillations in the atmosphere? It has been half-seriously suggested that man may some time develop a new æsthetic capacity which will enable him to enjoy the choral effects of color, and that this lucent harmony, or prismatic music, will afford a more exquisite pleasure, and a more complete expression of the deeper emotions, than is now offered by the harmonies of sound, based as they are on a smaller range of sensation, and addressed to a less perfect and comprehensive sense. The music of the spheres is photometric not sonometric, and the canticles of the stars are analogous to the wild melodies of nature. If we choose to exercise our fancy we may imagine that on some planet more advanced or more happily situated this noblest form of artistic expression has been fully developed, and that there the sparkling heavens pour forth a soundless music as yet unappreciated by our dull senses.

Yet, while the declaration of Aratus, that the heavens from all quarters speak to man, is universally true, there is no doubt that the proportion of mankind acquainted with the starry heavens and listening to their voices is smaller to-day than it was two thousand years ago. As astronomy has become more scientific in its aims and methods, it has drifted almost

beyond the ken even of educated people. It has become a science apart, cultivated by a select few, appealing occasionally to the sense of wonder in the multitude by some striking discovery, but upon the whole pursuing its way in solitary grandeur along unfamiliar paths, and uncomprehended except by experts.

From the popular point of view this is a great pity. As the astronomers, immersed in their technical labors, have ceased to dwell upon the beauties and wonders of the midnight sky which is visible to everybody, the public, lacking an incentive and guidance, has lost interest in the heavens. Yet the universe is there for everybody to see, and no observatory, no instruments, and no mathematics are needed to enable any person to enjoy the immensely ennobling and uplifting pleasure afforded by the contemplation of the stars and constellations that pass every night over our heads. It is only necessary to look.

The object of this book, then, is to recall busy men to that branch of astronomy which is within everybody's reach, which was once the principal branch, and the basis of all, and which becomes only the more interesting as the scientific aspects of the subject are developed. But with these strictly scientific aspects we are here little concerned. Let us get back to astronomy as the first star-gazers knew it, and with only the aid which they had—that of their eyes.

There is nothing that possesses a more fascinating interest, outside the practical concerns of life, than the constellations. Yet they have been virtually banished from modern celestial charts. There is nothing more beautiful in nature, and nothing that

appeals more powerfully to the imagination, than the fifteen or twenty great stars that from time immemorial have borne individual names; yet modern books on astronomy seldom take any trouble to enable their readers to recognize and know them. There is nothing more captivating to thought than the planets — Jupiter, Mars, Venus, Saturn — those mysterious worlds that circle with us around the sun; yet, outside a few observatories, who ever watches them, who knows even where to look for them?

It is quite time that an attempt should be made to correct so lamentable a state of affairs. I have been simply amazed by information which has recently come to me of the manner in which astronomy is regarded in our institutions of learning. More and more it is neglected. The public schools do not teach the constellations, do not tell their pupils where, or when, they should look for Sirius, or Aldebaran, or Arcturus, or at what time they can see "Boötes leading his hunting-dogs over the zenith in their leash of sidereal fire." To the vast majority, to nine hundred and ninety-nine out of every thousand, all these names are mere Greek. The colleges and universities teach their students nothing pertaining to the great universe beyond the earth, except a few mathematical formulæ, forgotten as soon as learned. Possibly this is unavoidable, in view of the constant encroachment of the trade-school spirit, but it is not irremediable. As long as men have eyes to see and minds to think, it needs but a word, a hint, a glance, to turn them with rapt and ever increasing attention to the wonders overhead.

II

CONSTELLATIONS ON THE MERIDIAN IN JANUARY

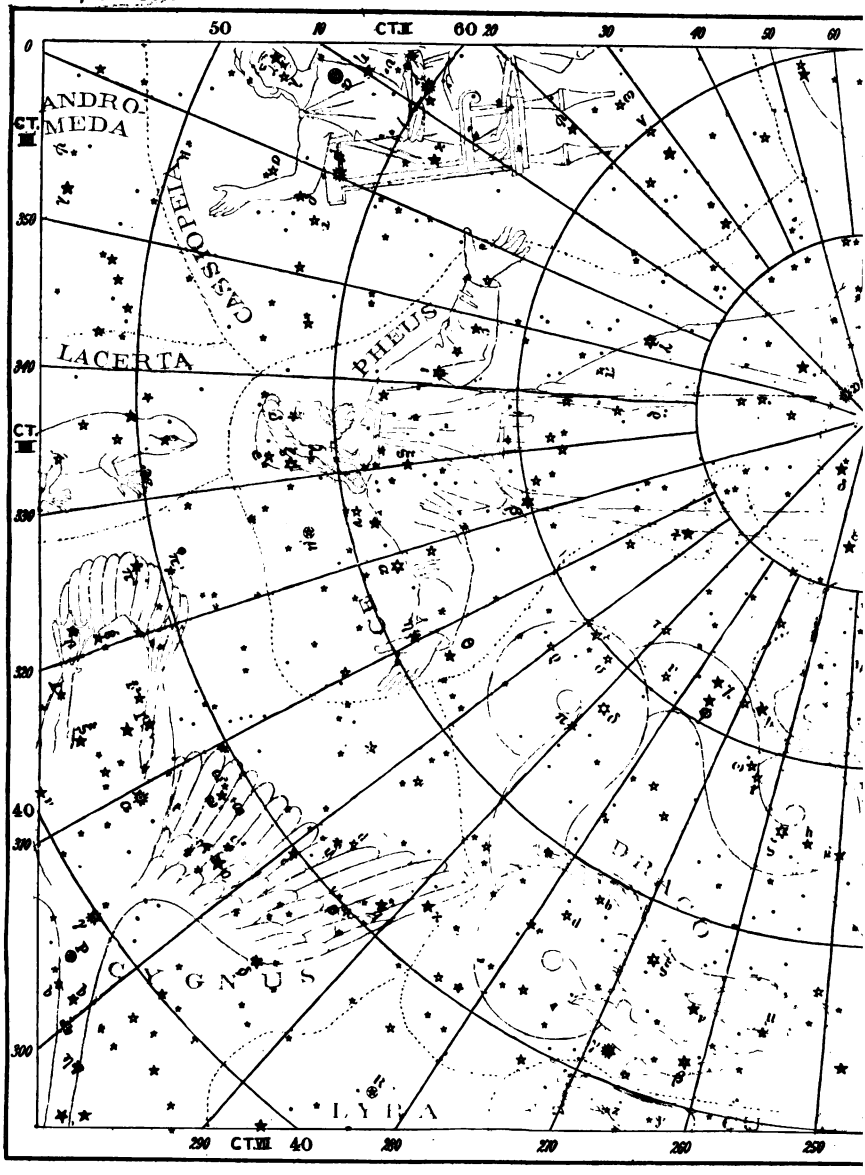
The meridian is an imaginary line traversing the sky from north to south and passing through the pole of the heavens (near the pole-star), and through the zenith, the point exactly over the observer's head. When a star crosses the meridian it is equidistant from its rising and setting points and is said to culminate. At noon the sun is on the meridian. The starry sphere (regarding the heavens as the shell of a hollow globe seen from the centre) has two apparent revolutions, one diurnal, caused by the earth's rotation on its axis, and the other annual, caused by the earth's revolution around the sun. In consequence of the annual revolution of the heavens the constellations seem to advance slowly from the east, new ones appearing above the eastern horizon each month, while old ones disappear behind the western horizon. Thus those that occupy a place on the meridian at any given hour are not the same from month to month. In this book the constellations are described in the order of their arrival on the meridian month after month, at about nine o'clock in the evening, in the middle of the month. Only those lying between the north pole and the southern horizon are described, as those situated below the pole may usually be better seen at another time.

Auriga

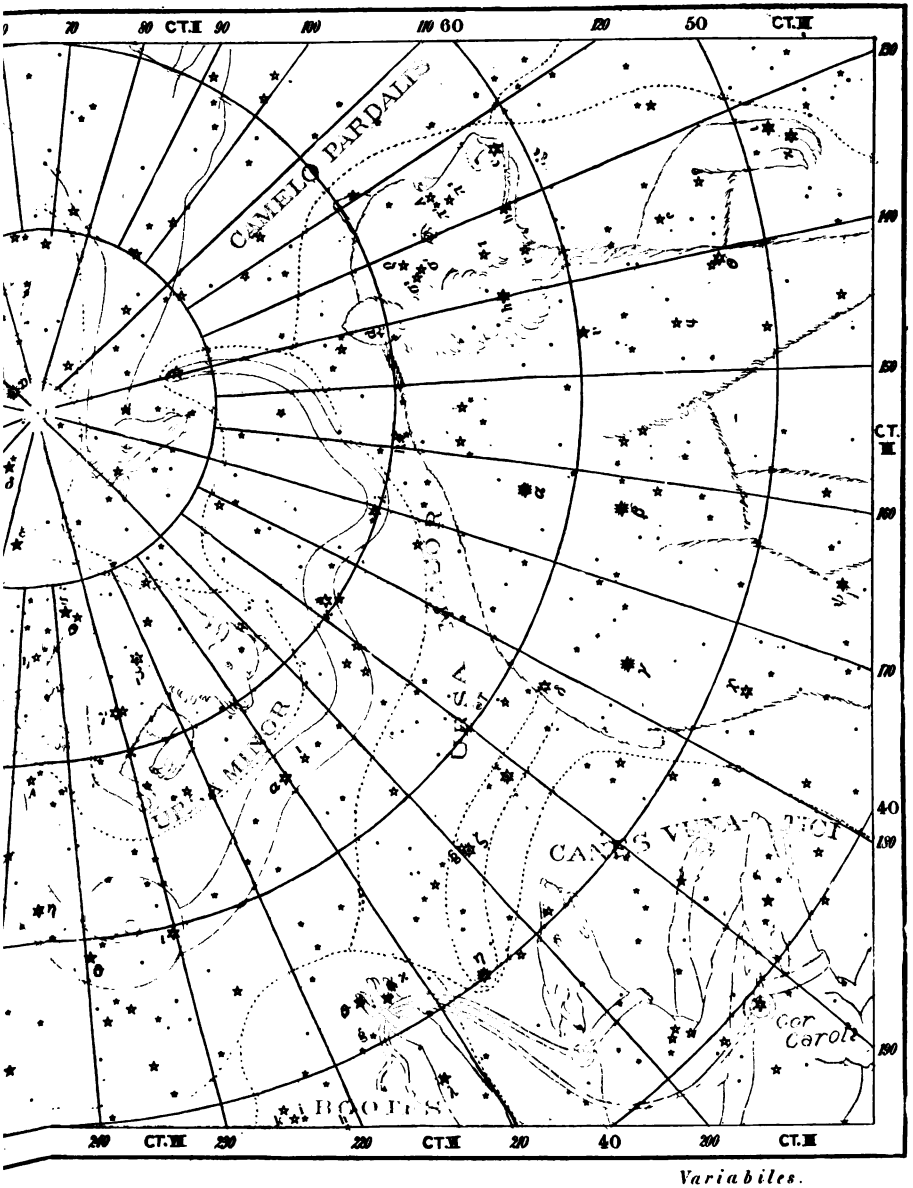
(CHART V)

IF you go out-of-doors at nine o'clock on a clear evening in the middle of January you will see overhead, and not far from the zenith, if your lati-

$\alpha = 25^h$, $\delta = +80°$.



1m 2m 3m 4m 5m 6m



Variabiles.

1m 2m 3m 4m 5m 6m

tude is near that of New York, a brilliant white star, of the first magnitude, and of remarkable beauty. It is the star celebrated in fable from remote antiquity under the name of Capella (*a* Aurigæ). At its great elevation, so near the centre of the starry dome, its light falls through an atmosphere so steady that it shows hardly a twinkle. Once in a while a lazy ripple seems to pass on the surface of the atmospheric ocean, the star flashes like a tipped mirror, and then immediately resumes its quiet beaming. The name Capella, as Mr. Allen says in his exhaustive work on *Star Names and Their Meanings*, signifies "the little She-goat." It is a curious fact that in many widely separated parts of the earth, and in widely separated times, Capella has borne this designation. Not only the Greeks and the Romans called it the Kid, but the ancient Peruvians, who knew nothing of European or Asiatic mythology, had a similar name for it in their language, Colca, and they connected it with the affairs of shepherds. For them instead of shining overhead it appeared far down in the north; but remembering that in the southern hemisphere, summer corresponds with our winter, it is evident that the time of Capella's culmination corresponded with the season when the shepherds would be watching their flocks.

Modern research has proved that Capella is a star of immense actual magnitude, exceeding our sun in brightness, according to Professor Newcomb, about one hundred and twenty times. It belongs to that very strange class of stars known as spectroscopic binaries, which term means that they consist each of

two stars so close together that no telescope is able to separate their disks, although their duplicate nature is proved by the periodic splitting of their spectroscopic lines as they revolve swiftly about their common centre of gravity. The period of revolution of the Capella system is one hundred and four days. The principal star almost exactly resembles the sun in its spectrum, while the companion resembles Procyon, a star further advanced in the order of development.

Capella is the leading star of the constellation Auriga, the Charioteer, or the Wagoner, which covers a large space in the sky, about 40° from east to west and 30° from north to south, and contains twenty stars from the first to the fifth magnitude inclusive. Auriga is a very ancient constellation, its origin being lost in antique myths. It has been represented for ages under the figure of "a mighty man seated on the Milky Way," and carrying a kid on his left arm. Capella shines in the heart of the imaginary kid. About ten degrees east of Capella is the second-magnitude star, Menkalina (β). This star marks the right shoulder, or upper part of the right arm, of the Charioteer. Menkalina, like Capella, is a spectroscopic binary, but its period is only four days, the spectroscopic lines appearing split every alternate night. The right foot of the Charioteer rests upon the tip of the northern horn of Taurus the Bull, the second-magnitude star, El Nath (β Tauri), being shared in common by the two constellations. A third-magnitude star, Iota (ι), about ten degrees northwest of El Nath, shines in the Charioteer's left

foot. Three fourth-magnitude stars, Epsilon (ϵ), Zeta (ζ), and Eta (η), which form a little triangle a few degrees southwest of Capella, indicate the left hand of the Charioteer, which supports the Kid. This little starry triangle is a sort of signboard to insure the recognition of Capella by beginners. A third-magnitude star, Theta (θ), about ten degrees south of Menkalina, with a fourth and two fifth-magnitude stars near it, marks the Charioteer's right hand, resting on his right knee, and bearing a long upright whipstock, the wind-driven thongs of which are represented by a scattered group of half a dozen fifth-magnitude stars with a few of the sixth magnitude among them. All of these bear the name of the Greek letter Psi (ψ), with distinguishing numerals. The head of the Charioteer bears a fourth-magnitude star, Delta (δ), with a fifth, Xi (ξ), above it. The Milky Way passes across the lower half of Auriga, Capella lying on its northern edge.

The mythological history of Auriga is not very clear. Allen, who thinks that the constellation originated among the early star-gazers of the Euphrates valley, mentions a sculpture from Nimroud on which the figures of the Charioteer and the Goat or Kid are represented almost as they are drawn to-day. Sometimes a chariot has also been represented here. By the Greeks Auriga was imagined to represent Erechtheus, son of Hephæstus and Athena, who was fabled to have invented the four-horse chariot, and to have been rewarded by Zeus with a place in the sky. The Romans followed this idea of the Greeks:

Close by the Kneeling Bull behold
The Charioteer, who gained by skill of old
His name and heaven, as first his steeds he drove
With flying wheels, seen and installed by Jove.
—*Manilius.*

Dr. Joseph A. Seiss, in his *Gospel in the Stars*, will have it that the Greeks were greatly puzzled by the constellation of Auriga, not understanding its origin, and that they only preserved here a traditional figure which had existed long before their time, and which represents the Good Shepherd who was to lay down his life for the sheep; in other words, a symbol foretelling the coming of Christ. In the zodiac of Dendera there is a representation of Auriga which, as Dr. Seiss interprets it, holds a sceptre, the upper part showing the head of a lamb and the lower part the form of a cross.

This constellation affords a good field for the opera-glass or telescope. The star 14 is a pretty double of magnitudes five and seven-and-a-half; distance apart, 14″; colors, pale yellow and bluish or greenish. The star 4 (also known as Σ 616) is a closer double; distance, 6″; magnitudes, five and nine; colors, pale red (although some say green) and light blue. The star 41 (Σ 845) is double; magnitudes, five and six; distance, 8″. The cluster (Σ 38) is very beautiful with a telescope. A number of its stars imitate roughly the form of a cross. Several other less brilliant clusters are scattered over this part of the constellation.

Camelopardalis

(CHART II)

Between Auriga and the pole lies the faint, strag-

gling constellation of Camelopardalis. It has no legendary or mythological interest, having been unknown to the ancients. It dates only from the seventeenth century, when it was first represented on a chart by Jacobus Bartschius, the son-in-law of the astronomer Kepler, who with poetic fancy saw in its stars an image of the camel that bore Rebecca on her way to join Isaac. It is always represented in the form of a giraffe. It has ten stars of the fifth magnitude and two of the fourth.

Taurus

(CHART V)

South and southwest of Auriga we find Taurus the Bull, the third constellation of the zodiac, and one of the most brilliant in the heavens on account of its two celebrated clusters, the Hyades and the Pleiades. The Hyades adorn the head of the huge charging bull, who threatens Orion with his long horns, while the Pleiades hang on his shoulder, like a glittering banderilla. The *lucida* (the name sometimes given to the brightest star of a constellation) of Taurus is Aldebaran, a first-magnitude star, of extraordinary beauty on account of the pale-rose tint perceptible in its light. This is situated in the right eye of the Bull, and at the top of the eastern arm of the capital letter V, which is plainly marked out by the stars forming the group called the Hyades. This group is one of the most striking figures in the starry heavens. With its neighboring cluster of the Pleiades it carries us into the very heart of myth-

ological romance. Nothing can be more beautiful than these stars seen high in the mid-heaven on a clear, frosty winter's night, in the absence of bright moonshine, and when there are no powerful electric or other lights near to dim the vision. The gem-like rays of Aldebaran are splendidly set off by the glitter of the smaller stars, which seem to have been arranged by the hand of a *bijoutier* to enhance the splendor of the principal jewel. Besides Aldebaran the group contains five stars of the fourth magnitude, two of them almost touching each other in the lower arm of the letter; four of the fifth magnitude, and half a dozen of the sixth. And all around the sky is rich with scattered gems. They have always been connected in the popular imagination with the weather, and especially with showery or rainy weather, the poets calling them the "rainy Hyades," the "watery Hyades," and so on. Mr. Allen remarks that they are among the few stellar objects mentioned by Homer, and Pliny said that they caused storms and tempests on both land and sea. This probably originated in their rising at the time when stormy weather usually begins.

The letter V just referred to has its three corners marked by Aldebaran, Epsilon (ε Tauri), and Gamma (γ Tauri). Epsilon marks the top of the northern branch of the V, and Gamma its point. About half-way between Epsilon and Gamma are a pair of stars, the larger, of the fourth magnitude, being Delta (δ Tauri.) Its companion, also sometimes called Delta, is of the fifth magnitude, and they form an attractive combination. Occupying a similar

position in the other branch of the V, between Aldebaran and Gamma, are two fourth-magnitude stars, much closer together, the Thetas (θ). It requires a good eye satisfactorily to separate these stars, and there is a fifth-magnitude star near them which increases the beauty of the sight. A little southeast of Aldebaran the eye catches another small pair, of the fifth magnitude, the Sigmas (ς). The Sigmas are only seven minutes of arc apart, less than one-fifth of the apparent diameter of the moon.

The smaller, fainter, and more compact group of the Pleiades is even more famous. They shine in poetry almost as they shine in the sky. Everybody knows by heart Tennyson's lines about them in "Locksley Hall," as well as the verse of Job in which their name is so poetically woven. They are mentioned in the fragments of "Sappho." Sir G. C. Lewis, in his *Astronomy of the Ancients*, says that their name evidently comes from the Greek word *plein*, to sail, because their rising was synchronous with the opening of the season of navigation in the Greek seas. They comprise one star (Alcyone), of the third magnitude; one (Maia) of the fourth; four (Atlas, Electra, Merope, and Taygeta) of the fifth, or near the fifth; and one (Celæno) of rather less than the sixth, so that only a sharp eye can see it. This is usually called the "Lost Pleiad," but that name has also been applied to Pleione, another member of the group too faint for ordinary vision. There is also a double, Asterope, which lies a little below the limit of ordinary eyesight. Alcyone, the *lucida*, is famous as the supposed centre of revolution of the starry

heavens, which the German astronomer Mädler imagined that he had detected. Astronomy knows no such centre of revolution, if any exists.

Within recent years marvellous photographs of the Pleiades have been made, showing this group of stars to be embedded in a wonderful mass of nebulous matter, the most singular in aspect of any in the heavens.

This wonderful nebula, or, rather, mass of intertwisted nebulæ, is not visible to the naked eye, and but little of it can be seen with telescopes. Yet the strange fact exists that every observer seems to *feel* that there is something else in the Pleiades besides the star rays. It is a kind of glimmer which is not starlight—or, at least, does not impress the eye as starlight, but rather as an indefinite, misty luminosity forming a background against which the stars appear. The descriptive truth of Tennyson's line about the Pleiades, when he says that they

> Glitter like a swarm of fireflies tangled in a silver braid,

impresses everybody who has ever seen them. The meaning of this intermingling of stars and nebulous matter may be that the Pleiades are a group of suns in which the formative process is but partially completed, a large part of the original chaotic matter remaining still uncombined and uncondensed.

Besides the two great clusters just described, Taurus contains a number of notable stars. El Nath or Beta (β) Tauri has already been mentioned as common to Taurus and Auriga, since it indicates the place where the foot of the latter rests upon the tip of the Bull's

horn. El Nath is of the second magnitude, and appears singularly beautiful when carefully observed, on account of its pure whiteness. Many other apparently white stars are seen to be slightly colored when compared with El Nath. About nine degrees below El Nath, in the direction of Orion, is a third-magnitude star, Zeta (ζ) Tauri, marking the tip of the southern horn. Between the two horns, and in the top of the head, are four or five fourth and fifth magnitude stars, and several of the sixth magnitude, which impart a glimmering beauty to the scene, and justify Virgil's epithet of the "golden horns" of Taurus. The body of the Bull ends abruptly just west of the Pleiades, and the old myth which represents Taurus as the bull into which Zeus transformed himself in order to carry off Europa, swimming with her through the sea, sufficiently accounts for the invisibility of the hind quarters of the animal, which must be supposed immersed in the waves. But his breast and forefeet are visible, and contain several moderately bright stars, which may be found on the chart.

Taurus contains one star of the first magnitude; one of the second; three of the third; ten of the fourth; twenty-seven of the fifth; and a crowd of the sixth.

Taurus is rich with myths and legends. The identification of this constellation with the bull of Europa has already been mentioned. It seems to have been regarded as a bull in all of the ancient Mediterranean countries, and also in countries far distant from Europe, and the natal lands of Greek

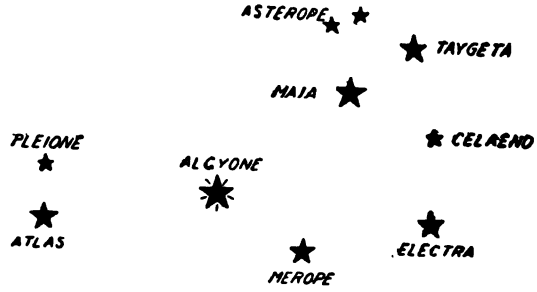
mythology. The Indians of the Amazon, according to some of the early explorers in South America, called it the Ox. In Egypt it was identified with Osirus, the bull-god, although there is some question as to the time when this identification occurred. It may have been subsequent to the Greek legend. But, at any rate, the constellation always played an important part in the Egyptian religious ceremonies connected with the zodiac, and there was a belief in Egypt that the human race sprang into being at a time when the sun was in Taurus. It seems also to have been identified by the Egyptians with Apis, the bull-god of the Nile, and in this form, as Mr. Allen suggests, it may have been known before the building of the great pyramids. Among the Chinese, when white men first visited them, this constellation was known as the White Tiger, but after the Jesuit Fathers had introduced occidental ideas its name in China became the Golden Ox. The idea of "whiteness" in connection with Taurus seems to have had a very early origin. This probably arose from the legend that Europa's bull was snowy white, for the great ruler of Olympus could not be expected to turn himself into an ordinary brindle beast when he was going to carry on his back the beautiful rival of his queen!

But the myths pertaining to Taurus centre particularly around the two groups of the Hyades and the Pleiades. I have mentioned above the charming legend of the Onondaga Indians concerning the Pleiades. This legend brilliantly expresses their poetic attractiveness, but there are many older ones,

found everywhere in the world, which show that the Pleiades have always impressed mankind with a sense of mystery. From ancient Egypt and Chaldea to the shores of the Northern Ocean; from Japan to Australia and the island groups of the South Pacific; from the Great Lakes of North America to Mexico and Peru, traces have been found of a strange worship of this group of stars. They have been connected in a most remarkable manner with legends of a deluge, and their cult has often assumed the form of a festival of the dead, as among the Egyptians. The Spanish conquerors found in Mexico a tradition that the world was once destroyed when the Pleiades culminated at midnight. The Japanese Feast of Lanterns has been supposed by some to be a survival of an ancient rite relating to the Pleiades, and commemorating a vast calamity which overwhelmed the race of man at some period in the remote past when that group of stars happened to occupy a conspicuous position in the sky. There seems to be no doubt that one of the mysterious passages constructed through the heart of the pyramid of Cheops was intended to point to the Pleiades at the moment when they passed their upper culmination at the hour of midnight. It has even been suggested that the Europa myth, already mentioned, may have originated in the tradition of a connection between the Pleiades and an apparently universal deluge, since it introduces the idea of a flood of waters through which the Bull is struggling with more than half his body submerged. The Druids also had a cult of the Pleiades, or at any rate of the

constellation Taurus, and, in connection with this, Mr. Allen mentions an old Scotch myth concerning the Candlemas Bull, which is said to appear at twilight, rising in the east and sailing across the sky.

But the most definite of the Pleiades legends is that which connects them with the seven daughters of Atlas, the "Atlantid nymphs." Of these Alcyone is the chief, and is sometimes called "the light of the Pleiades." Maia was both the eldest and the most beautiful of the daughters, although her star is less brilliant than that of her great sister. Electra was the mother of Dardanos, the founder of Troy, and the legend avers that upon the destruction of that city she covered her face and has never since shone as bright as before. Merope is also said once to have faded in shame at the recollection of her having married a mortal. But in this she was not singular among her immortal sisters. Taygeta was the patron goddess of Sparta, since her son Lacedæmon founded that redoubtable little state. The other two sisters were Celæno and Asterope, both of whose stars are faint, and one of them, as already mentioned, double. An eighth member of the group, hardly visible to the naked eye, is Pleione. She was the mother of the seven sisters and her star may be the true "Lost Pleiad" of the legend, rather than either Electra or Merope, because modern spectroscopic investigation has shown that Pleione bears evidence of a temporary character. Atlas, the father, also has his star, which shines a little below Pleione, but is much brighter. On the accompanying little chart the names of the Pleiades will be found.



Although their history is as old as that of the Pleiades, the Hyades have a less extensive mythology. They also were supposed to be daughters of Atlas, half-sisters of the Pleiades, their mother being Æthra. They are said to have been the nurses of the infant Bacchus, and Zeus rewarded them with a place in the sky. Unlike the Pleiades, the names of these nymphs were never individually distinguished by applying them to particular stars. The entire group was simply regarded as being composed of the sisters, and the name Aldebaran was formerly applied to it as a whole.

According to Dr. Seiss, the modern exponent of religious mysticism among the stars, the constellation Taurus represents the fabled Unicorn, and the Egyptians, although not appreciating the divine spirit of prophecy that guided them, called it by names signifying "the Head, the Captain, the Mighty Chieftain who cometh," the real symbol being that of "Christ as the irresistible and Angry Judge." The sister stars of the Hyades and Pleiades, according to the same authority, "beautifully symbolize the

saints, securely supported by the terrible Judge, and who, together with the holy angels, whom they are like, thus move with Him and His inflictions upon a guilty world."

Perhaps Dr. Seiss's interpretation has as much foundation as the older myths, but certainly it lacks their charm.

In a small telescope Alcyone presents a captivating sight, on account of the presence of two minute stars forming a little triangle with it. Aldebaran, remarkable, as already pointed out, for its pale ruby color, has a distant tenth-magnitude companion. Aldebaran is one of the standard first-magnitude stars. The star Lambda (λ) is a rapid variable, changing from about the third to about the fourth magnitude once in every four days. About one degree northwest of the star Zeta (ζ), at the tip of the southern horn, is the celebrated "Crab Nebula," which is only to be seen with a very powerful telescope. It presents an extraordinary appearance when photographed.

Orion

(CHARTS V AND IX)

Southeast of Taurus flashes the "Golconda of the heavens"—the brilliant constellation Orion. The celestial equator passes through the centre of this constellation, almost touching the northernmost star in the Belt. The two great first-magnitude stars, Betelgeuse and Rigel—the former something over ten degrees above, and the latter an equal distance below the three stars forming the Belt—seem balanced against each other. Their splendid contrast

of color, and the dazzling beauty of the stars in the Belt, which lie in an almost true straight line, and are matched as perfectly in size and tint as selected gems, impart to this constellation the appearance of a gigantic piece of jewelry. There is nothing else in all the sky to equal it in splendor. The famous Southern Cross is far inferior to Orion as a celestial spectacle. The unparalleled magnificence of the constellation of Orion lifts the name of a comparatively obscure hero of Grecian mythology to a prominence before which even Zeus, or Jupiter, and the other great Olympian gods and goddesses dwindle to relative insignificance. Jove is fabled to have placed Orion among the stars as a reward of merit—as merit was reckoned in those days—but surely he could never have looked upon the splendid constellation which he thus gave away, else he would have reserved it to enshrine his own fame. Orion is one of the few constellations visible from all parts of the earth.

Now, near the twins behold Orion rise.
His arms extended measure half the skies;
His stride no less. Onward with steady face,
He treads the boundless realms of starry space;
On each broad shoulder a bright gem displayed,
While three obliquely grace his mighty blade.
On his vast head three lesser stars are seen,
Their rays commingled in a silvery sheen,
So far removed that half their splendor's lost.
Thus graced and armed he leads the heavenly host.
—*Manilius.*

The traditional figure of Orion is that of a Hercules standing with uplifted club to confront the Bull, who

is charging down upon him from the circle of the zodiac. Thrown over his left arm like a shield is a lion's hide, represented in the sky by a remarkable bending row of small stars. Betelgeuse glitters on his right shoulder and Rigel on his left foot. His left shoulder is epauletted with the star Bellatrix, not so bright as the other two, but still a beauty. It is sometimes called the Amazon Star. These three are the leaders of the constellation, Betelgeuse being honored with the name Alpha (α), while Rigel is Beta (β), and Bellatrix is Gamma (γ). Both Rigel and Betelgeuse are above the standard first magnitude, and approach the zero magnitude mentioned in Chapter I. Rigel is ordinarily the brighter, although it ranks in nomenclature below its rival. Betelgeuse is irregularly variable, and probably the first letter of the alphabet was assigned to it at a time when it was in one of its brilliant moods. It attained a great degree of splendor in 1894. Since then it has been fainter than Rigel, but now (1908) it is brighter. In 1852 it was so brilliant that it was reckoned the brightest star north of the equator, brighter than either Capella, Vega, or Arcturus. Its color is remarkable, a rich topaz hue, especially when viewed with a glass. The color appears to vary with the brightness, the tone becoming deeper as the star grows fainter. This would indicate that it is entering upon the earlier stages of extinction. At present it must be a sun of prodigious splendor. It is so distant that its parallax has not been certainly ascertained, and from this it follows that it exceeds our sun in intrinsic brilliance probably thousands of times,

because the sun at its distance would be invisible. The name Betelgeuse is derived from the Arabic, and means "The Armpit of the Central One."

Rigel, which generally appears a little brighter than Betelgeuse, is an equally distant and equally great sun, possessing, according to Professor Newcomb, possibly ten thousand times the intrinsic brightness of our sun. Its color is invariably brilliant white with a tinge of blue, the color of a diamond of the first quality. If Betelgeuse is a sun falling into decrepitude Rigel is one enjoying the heyday of solar youth.

Bellatrix is of the standard second magnitude and of a yellowish color. It is often called Mirzam, a name, as we shall see, applied to one or two other stars. Even Betelgeuse was sometimes called Mirzam by the Arabs, the word meaning Announcer or Herald.

The three stars in the Belt, which is about three degrees in length, and which adds so strikingly to the picturesqueness of the constellation, are named, respectively, beginning with the northernmost, Mintaka, Alnilam, and Alnita. Their Greek letter designations, in the same order, are Delta (δ), Epsilon (ϵ), and Zeta (ζ). The first two are white, the third slightly yellowish. In the right knee is a star of near the third magnitude called Saiph, or Eta (η). Saiph, Rigel, Bellatrix, and Betelgeuse mark the corners of an irregular parallelogram, about eighteen degrees in its greatest length, and having the Belt in its centre.

Below the Belt hangs the Sword made conspicuous by a short row of stars of the fourth and fifth magnitudes, the lowermost of which, Iota (ι), is rather

brighter than fourth magnitude. The middle star, Theta (θ), is involved in misty light. This light comes from the celebrated Great Nebula of Orion, one of the most astonishing objects in the firmament of heaven. A good opera-glass shows this nebula, and in a telescope its appearance is wonderful beyond description. A third-magnitude star, Eta (η), below Mintaka, and making a right angle with the line of the Belt, indicates the handle of the Sword.

The Head of Orion is represented by a group of stars, somewhat crowded in appearance, the principal member of which is Lambda (λ), of the third magnitude. The Arabs called the head of Orion Al Hakah, meaning a White Spot. Its glimmering aspect may be thought to justify this designation. Mr. Jules A. Colas has called attention to the curious fact that the full moon could be inserted in the little triangle of stars constituting the head of Orion. This is an instructive example of the exaggerated impression of size that the moon makes upon the eyes of persons unaccustomed to astronomical observation, for few could be found willing to believe that its disk would not cover a far greater space. The uplifted Club of Orion, and his right hand which holds it, contain five fifth-magnitude stars and several of the sixth magnitude. The upper end of the Club is almost on a level with the point of the southern horn of Taurus.

The Lion's Hide which Orion bears on his left arm, like a shield, contains four stars of the fourth magnitude, two of the fifth, and about ten of the sixth, which impart to it a curious glimmer.

Orion contains altogether two stars of the first

magnitude (really brighter than first magnitude); four of the second; four of the third; three of the fourth; twenty-four of the fifth; and a great number of the sixth. According to Burritt, there are seventy-eight stars visible to the unaided vision, but most eyes do not distinctly discern so many. An opera-glass reveals many hundreds.

As already indicated, Orion is of great mythological fame. A far more brilliant constellation has been assigned to him than to the great hero Herakles, or Hercules, yet he plays comparatively an inconspicuous and uncertain part in the old myths. He is generally regarded as a mighty hunter of gigantic stature, so tall that he could wade the sea. Some say he was the son of the Amazonian queen Euryale and Neptune, and boasted that the mightiest beasts of the earth could not successfully strive with him. Then a scorpion bit him, and when he died of the wound the gods placed him among the stars. According to another story, he was born, like Athena, without a mother, and became so famous as a worker in iron that Vulcan employed him to build a palace under the sea. Still another legend avers that he offered violence to the daughter of Œnopion, King of Chios, who thereupon put out his eyes when he was asleep. But Vulcan, remembering his services, sent him a guide to lead him to a place where he could confront the rising sun, and its rays restored his sight. According to some, Orion had one of his own forgemen carry him on his back to meet the sun. It is also said that Diana fell in love with him, thereby arousing the jealousy of Apollo, who persuaded the

goddess to a trial of skill at archery. Diana aimed a shaft at an object in the sea and pierced it. It was the head of Orion, who was amusing himself by wading far from shore. Having killed him with her arrow, Diana had him transported to the heavens, and made him outshine all his rivals there. We may smile at these legends, yet as products of the human imagination they cannot but interest us when we see them perpetuated among the stars. But for his constellation Orion would never have been remembered; now he has a monument more lasting than the pyramids.

Among the Arabs the constellation Orion was known as Al Jauzah, a term of uncertain signification. The translation "Giant," Mr. Allen thinks, is incorrect. The Egyptians said that the soul of Osiris rested in Orion. Among the Jews, Orion was the great hunter Nimrod. The ancient Hindoos said that he abased his own daughter, the rosy Aldebaran, whereupon Sirius transfixed him with an arrow, represented by the three stars of the Belt. In English popular lore the Belt is called the "Yard and Ell." The Chinese knew Orion under the name of Shen. For Dr. Seiss, and his *Gospel in the Stars*, Orion stands as a prophetic representation of the great "enemy and destroyer of death," and all the ancient myths are rehandled to accord with this interpretation.

In telescopic objects Orion is wonderfully rich. Most famous of its double stars is Rigel. The companion may be seen with a three-inch telescope. Its distance is 9.5″; color, deep blue; magnitude, eight—a most beautiful object. Alnita (ζ) in the Belt is

triple; magnitudes, second, sixth, and tenth; distances, 2.5″ and 56″; colors, yellowish white, grayish purple, pale blue. Delta (δ) in the Belt is double; magnitudes, second and seventh; distance, 53″; colors, white and greenish white. Sigma (ς) is multiple, the telescope showing eight or ten stars varying from the fourth to the tenth or eleventh magnitudes, and exhibiting divers tints, one star of the seventh magnitude being described as "grape-red." Theta (θ) in the Sword is quadruple, and the telescope shows it surrounded with the Great Nebula, a true wonder-cloud which can be very well seen with a three-inch telescope. Lambda in the Head is double; magnitudes, three-and-a-half and sixth; distance 4″; colors, light yellow and reddish. Orion also contains many doubles which are not visible, or not easily visible, as single stars to the naked eye. The whole constellation is enveloped in a gigantic nebula, traces of which may be seen with powerful telescopes, but which only reveals itself in its entirety in long-posed photographs.

Eridanus

(CHARTS VIII AND IX)

Directly west of Rigel, the starry river, Eridanus, takes its rise. It goes winding far westward, under Taurus, and finally, after meeting Cetus, the Whale, turns abruptly southward. Then making a long reach back eastward, it arrives almost under its starting-point, and at last drops beneath the horizon of northern middle latitudes. As soon as the eye has once traced out the "river," its resemblance to a stream becomes quite striking. The entire length of this river of stars is no less than a hundred and

thirty degrees. It is sometimes divided, for convenience of reference, into two streams, or reaches, the northern stream reaching westward from Orion to Cetus, and the southern stream, which, as already remarked, runs back nearly to the longitude of the source. Many of the stars of Eridanus are strikingly arranged in pairs. Far down in the southern hemisphere, invisible from latitudes north of 32°, Eridanus possesses a splendid star of the first magnitude named Achernar. But for us of the northern hemisphere its brightest star is Cursa, or Beta (β), some three degrees northwest of Rigel in Orion. The name Cursa, Mr. Allen explains, comes from an Arabic word signifying the footstool, this star being regarded as a support for the left foot of Orion, on which Rigel blazes like a gem-set shoe-buckle. The star Gamma, also called Zaurak, seems to have been connected with the idea of a boat afloat in the stream. Cursa is rather above the third and Zaurak a little below that magnitude. The other stars in the northern stream specially worthy of note are Nu (ν), the pair of the Omicrons (o), Delta (δ), and Epsilon (ϵ), which are near together, Zeta (ζ), and Eta (η). Nearly three hundred naked-eye stars have been catalogued in Eridanus, but the ordinary star-gazer will not notice more than thirty or forty.

> The scorched waters of Eridanus, tear-swollen flood
> Welling beneath the left foot of Orion.
>
> —*Aratus.*

These lines of the old Greek poet indicate the connection which some of the ancients made between

Eridanus and the story of Phæton, the ambitious son of Phœbus, who persuaded his father to allow him to drive for one day the Chariot of the Sun, and whose wild ride nearly resulted in the burning up of the earth, when his coursers, feeling a feebler hand on the reins, took the bits in their teeth and ran away with the Sun, leaving the track of Zodiac, and dashing so close to the earth that it began to smoke. Order was restored by Jove, who smote the presumptuous youth with a thunderbolt and precipitated him into the river Eridanus, whose nymphs "swelled the flood with their tears," shed in mourning over the fate of their unhappy favorite. This story has been thought to contain the fading memory of some season of terrible drought, that brought famine and disaster to the Mediterranean lands. Jove is said to have turned the weeping nymphs into poplars, the tree now so abundant in the valley of the Po (Eridanus), and Ovid has commemorated their grief in these lines:

"All the long night their mournful watch they keep,
And all the day stand round the tomb and weep."

Dr. Seiss says Eridanus is the "River of the Judge," and refers to Daniel's vision of the four beasts that were cast into a fiery stream.

The star 32 Eridani is a superb double; magnitudes, fifth and seventh; distance, 6.7″; colors, topaz and ultra-marine. The lower of the Omicrons (o^2) is triple; magnitudes, fourth, tenth, and eleventh; distances, 82″ and 2.6″. A powerful telescope is required for this object. The star 12 Eridani is a close binary; magnitudes, fourth and eighth; distance, 2″.

Lepus

Below Orion's feet the Hare
Is chased eternally; behind him
Sirius ever speeds as in pursuit,
And rises after, and eyes him as he sets.
—*Aratus.*

The eye is led to Lepus by the conspicuous aspect of its little quadrangles and triangles of stars lying just south of Orion. It contains two stars of the third magnitude, Alpha (α) and Beta (β); six of the fourth, Mu (μ), Epsilon (ϵ), Gamma (γ), Delta (δ), Zeta (ζ), and Eta (η); and ten of the fifth. Mu is situated in the eye of the animal, and Eta in the tail. Three fifth and one sixth magnitude stars, forming a little quadrangle, mark the ears, lying just below Rigel.

The lines already quoted from Aratus tell the mythological story of Lepus. The hare has always been a favorite victim of the hunter's skill, and it seems to have been no less a favorite with Orion. The Great Dog, Sirius, is Orion's hound chasing the Hare. In Dr. Seiss's gospel mythology Lepus is interpreted as typifying the overthrow of the enemy of mankind, and he remarks that in Persian and Egyptian zodiacs the figure represented is that of a serpent trodden under the feet of Orion.

The star R Leporis is very remarkable for its intense crimson color, which has been compared with that of a drop of blood. It is variable, and the color is deepest when the star is faintest. The star Kappa (κ) is double; magnitudes, fifth and eighth; distance,

2.5″; colors, pale yellow and blue. The star Iota (ι) shows in the telescope a beautiful tinge of green, which is comparatively a rare color among the stars. It has an eleventh-magnitude companion, distant about 13″.

Columba

The constellation of Columba, the Dove, south of Lepus, has one star, Alpha (α), or Phaet, of the second magnitude, one, Beta (β), of the third, and two, Epsilon (ε) and Gamma (γ), of the fourth. It is said to represent the Dove that Noah sent forth from the ark. The constellation appears to have first been named in the sixteenth century. Norman Lockyer, in his *Dawn of Astronomy*, avers that Phaet was particularly worshipped among the ancient Egyptians, no less than a dozen temples having been oriented to this star. Mr. Allen records the curious fact that the Chinese call Phaet *Chang Jin*, the "Old Folks."

III

CONSTELLATIONS ON THE MERIDIAN IN FEBRUARY

Canis Major

(CHART IX)

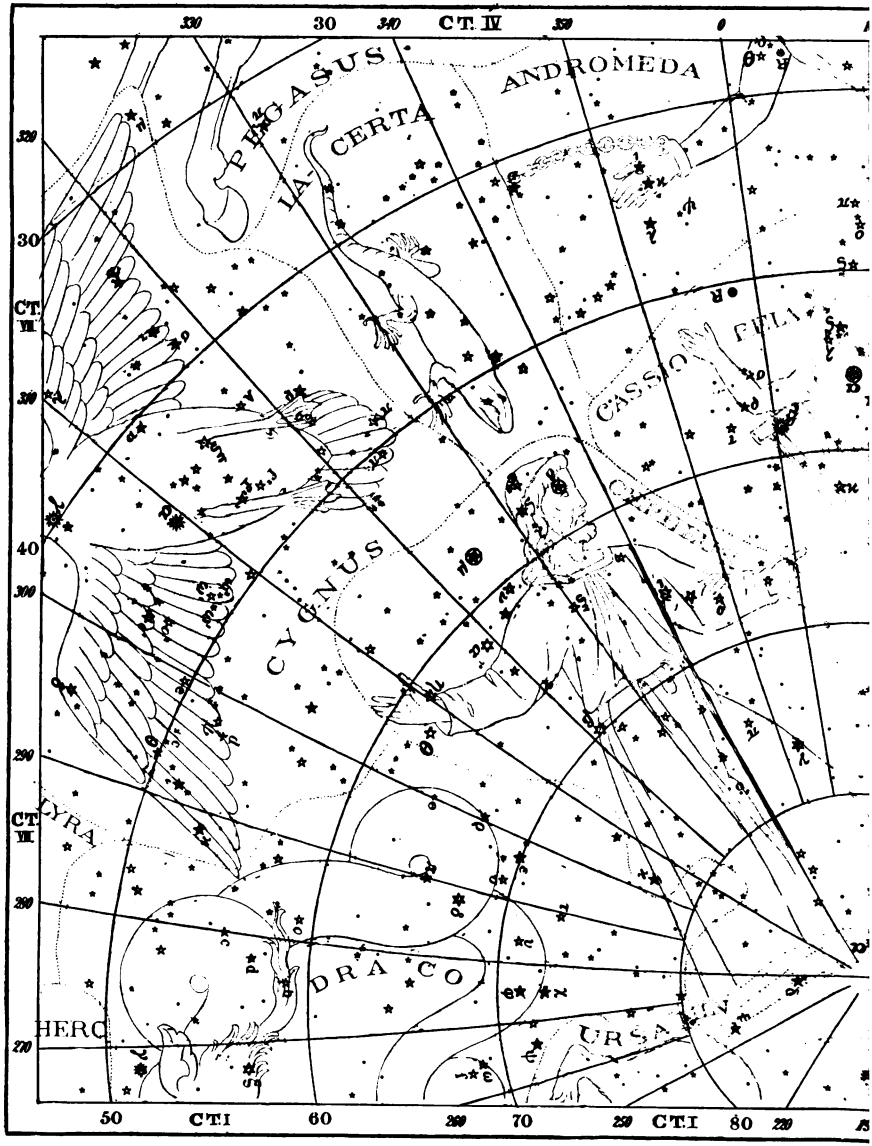
LOOK directly towards the south at nine o'clock in the evening in the middle of February, and you will see the brightest of all stars—Sirius, the Dog Star. It is situated about sixteen and a half degrees south of the celestial equator, and is the leader of the constellation Canis Major, the Greater Dog.

> . . . In his fell jaw
> Flames a star above all others with searing beams
> Fiercely burning, called by mortals Sirius.
>
> —*Aratus.*

The name of this magnificent star has been derived by some from the Greek word σειρος ("sparkling" or "scorching"; by others from the Egyptian *Osiris;* by Dupuis from the Celtic word *Syr.* All readers of the Iliad will recall the passage in which Achilles is likened to this star as he rushes across the plain of Troy to encounter Hector at the gates:

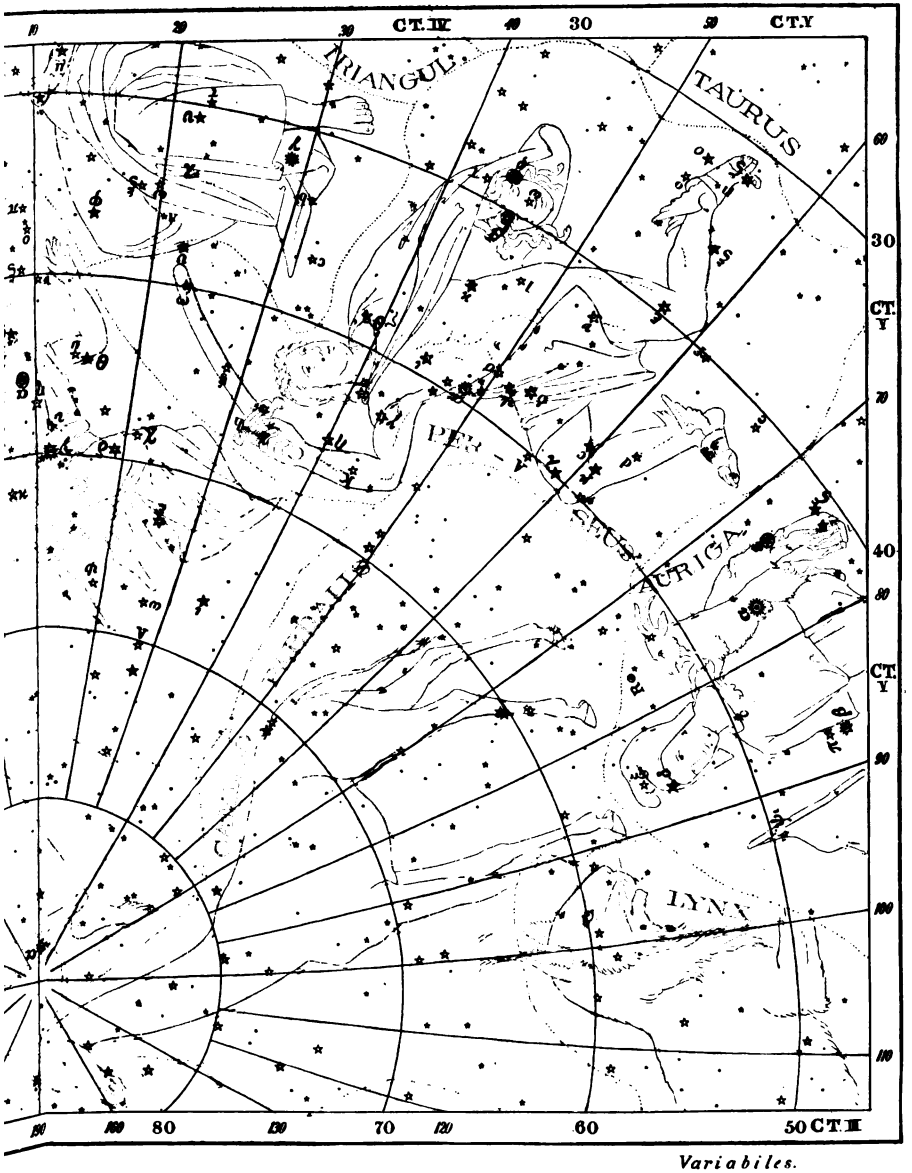
"Him the old man Priam first beheld, as he sped across the plain, blazing as the star that cometh forth at harvest time,

$\alpha - 10°$, $\delta - 167°$.



1m 2m 3m 4m 5m 6m

Chart II



CT. IV
CT. V
CT. III
TRIANGUL.
TAURUS
PER-
SEUS
AURIGA
LYNX
Variabiles.
1m 2m 3m 4m 5m 6m

and plain seen his rays shine forth amid the host of stars in the darkness of the night, the star whose name men call Orion's Dog."—*Iliad, bk.* xxii. (Lang and Leaf's Translation).

It is impossible to be guilty of exaggeration in speaking of the splendid beauty of Sirius. Its radiance is as indescribable as that of a great diamond. As remarked in the introductory chapter, it stands in a class by itself as far as magnitude is concerned. It has a hundred moods, according to the state of the atmosphere. Sometimes, when the air is still, the star burns with a steady white light, unflickering, like a core of electric fire; then, as invisible atmospheric waves flow over it, its rays spread and leap and flutter, breaking into keen prismatic darts that almost cause the eye to wince. By turns it flames, it sparkles, it glows, it blazes, it flares, it flashes, it contracts to a point of intensest brilliance or expands into a coruscating spectrum. There is some evidence for thinking that two thousand years ago its prevailing hue may have been red. From its cross-motion in space it has been calculated that six hundred centuries ago it was on the eastern border of the Milky Way; now it is on the western border.

"Since Sirius crossed the Milky Way
Full sixty thousand years have gone,
Yet hour by hour and day by day
This tireless star speeds on and on.

"Methinks he must be moved to mirth
By that droll tale of Genesis,
Which says Creation had its birth
For such a tiny world as this;

To hear that One who fashioned all
  Those solar systems tier on tiers,
Expressed in little Adam's fall
  The purpose of a million spheres!

On planets old, ere form or place
  Was lent to earth, may dwell, who knows?
A godlike and perfected race
  That hails great Sirius as he goes.

—*E. W. Wilcox.*

But splendid beyond comparison as he appears to our eyes, Sirius is now known not to be, by any means, the greatest sun in space. He owes his apparent primacy to his relative nearness. His distance is only a little over eight light-years (a light-year is the distance that a wave of light travels in a twelvemonth), or, say, forty-seven trillions of miles, and his intrinsic brilliance exceeds that of the sun only thirty times, while such stars as Rigel and Betelgeuse may be thousands of times brighter than the sun. Sir G. C. Lewis remarks that the time of Sirius's rising with the sun was connected at an early period, with the idea of intense summer heat, and Müller conjectures that it was called the Dog Star on account of the prevalence of canine madness at that season. Some think that Sirius is identical with the Mazzaroth of the book of Job. Its midnight culmination, or passing of the meridian, was celebrated in the Eleusinian Mysteries. Four hundred years before the Christian era Sirius rose just before the sun at the hottest season of the year, whence the *dies caniculariæ*, or "dog days," of the Romans.

The spectrum of Sirius is typical of a class known

as the Sirian stars, which include, perhaps, half of all that are visible, and which are characterized by a brilliant white color and broad absorption bands, indicating the presence of enormous quantities of hydrogen. They are believed to represent a relatively early stage of solar evolution, so that Sirius is to be regarded as a youthful giant among the suns.

After the princely splendor of Sirius, the other stars of Canis Major seem insignificant, and yet the constellation when well above the horizon presents a striking appearance. Sirius is in the jaw of the imaginary dog. The second star of the constellation, Beta (β), or Mirzam, of near the second magnitude, is in one of the uplifted paws, towards Lepus. Delta (δ), also called Wezen, and Epsilon (ϵ), also called Adara, are in the right flank, the dog standing nearly upright on its hind legs. These stars are of the full second magnitude and brighter than Mirzam. Zeta (ζ), or Furud, in the right hind paw, is of the third magnitude, as is Eta (η), or Aludra, in the tail. The last-named star is, however, rather the brighter of the two. There are seven stars of the fourth magnitude and fourteen of the fifth, besides many of the sixth. A comparatively empty space separates Sirius with its group of attendants from the more southern stars of the constellation, so that the latter seem almost to form a constellation by themselves.

Just east and northeast of the tail of the Dog is a group of fourth and fifth magnitude stars which mark the prow of Jason's Ship in the constellation Argo. But the larger part of this constellation lies too far south to be seen from the mean latitude of

the United States. It will be described in the chapter on the southern stars. Its principal star, Canopus, ranks next to Sirius in brightness, and can be seen from the extreme southern parts of the United States. It is almost directly south of Sirius, at a distance of about 35°.

The mythological history of Canis Major, as already indicated, is intimately related to that of Orion. But the constellation, or at least its principal star, seems to have been associated with the idea of a dog among ancient nations unacquainted with the myth of Orion. Thus among the Scandinavians it was regarded as the dog of Sigurd. In ancient India it was called the Deerslayer. Some of the early Greek myths represented it as the hound of Actæon, and also as one of Diana's hunting dogs. Mr. Allen mentions the curious facts that an ivory disk, found by Schliemann in his excavations on the site of Troy, contains a representation of a dog believed to be Canis Major, and that an ancient Etruscan figured mirror shows this constellation, together with Orion and Lepus, with the neighboring stars correctly located. Those who find a prophecy of the coming of the reign of Christ in the constellations have made much of Canis Major. Novidius called it the Dog of Tobias. Dr. Seiss claims that it represents the Messiah himself, "the Appointed Prince." He has a curious passage in which he derives the name Sirius from the word *Seir*, meaning "Prince," or "Guardian," and then connects this with "*Naz-Seir*," found in an Egyptian zodiac. Thus he arrives at the word "Naz-seir-ene," whence "Nazarene," and lo! an ex-

planation of the much-discussed origin of the prophecy that Christ should be called a Nazarene!

In Egypt the Dog was regarded as the celestial forerunner of the annual flood in the Nile, announcing the coming of the waters by rising just before the sun. Mr. Lockyer has found seven Egyptian temples which were so oriented as to receive upon their altars the rays of Sirius rising. In the famous zodiac of Dendera, Canis Major appears in the form of a cow carried in a boat. It was also represented as the goddess Sothis, and bore likewise the names of Isis, Osiris, and Thoth. As the "Nile star," Sirius was worshipped under the name of Sihor. Its supposed influence in causing the annual flooding of the river is indicated in the zodiac of Dendera by overflowing urns.

Sirius is a famous double star. The companion, of the ninth magnitude, revolves around Sirius in a period of about forty-nine years. The apparent distance, therefore, varies. In 1890 the two stars were so close that no telescope could separate them. In 1896 Burnham, then at the Lick Observatory, caught sight of the companion emerging from the overpowering rays of its primary, and since then the distance has been slowly increasing. In 1905 it had become about 6″. A very singular fact is that this companion, although ten thousand times less bright than Sirius, is nearly half as massive as its great neighbor! The star Mu (μ) is double; magnitudes, fifth and eighth; distance, 2″.8; colors, white and pale blue. About four degrees south of Sirius is the star cluster 1454, which presents a beautiful view in the telescope, having a red star near the centre, and curving rows of minute stars about it.

Monoceros

(CHART IX)

North of Canis Major and the prow of Argo lies Monoceros, the Unicorn, an inconspicuous constellation covering a space 40° long from east to west. It has but four stars as bright as the fourth magnitude, and these are scattered. In addition there are thirteen of the fifth magnitude, five of which appear in the head, which faces Orion, with the horn nearly touching his club. The stars of this constellation have not even enjoyed the honor of having the letters of the Greek alphabet applied to them, much less of being designated by special names. They are only indicated by numerals. It is a modern constellation, and has no mythological history. It is interesting for those possessing telescopes on account of its many small clusters of stars, and for one beautiful triple, the star 11, whose magnitudes are fifth, sixth, and seventh; distances, 7″.4 and 2″.7. The star 8 is double; magnitudes, fifth and seventh; distance, 14″; colors, golden yellow and lilac. A little northeast of 8 the eye catches a faint glimmering point which is expanded by a telescope into a beautiful cluster, No. 1424.

Canis Minor

(CHART IX)

Above Monoceros shines Canis Minor, the Lesser Dog, two of whose stars are conspicuous, the large, beautiful, first-magnitude brilliant Procyon, and its

attendant, some five degrees northwest, Beta (β), or Gomeisa, of the third magnitude. Gomeisa has near it two fifth-magnitude stars. Canis Minor is only about fifteen degrees in its greatest length, and contains only three fifth-magnitude stars in addition to those already mentioned. It owes its fame entirely to Procyon, one of the most interesting stars in the heavens. Its comparatively lone situation emphasizes its brightness, and it is rather nearer the Zero than the First Magnitude. Yet its light always impresses me as lacking the brilliance that one expects from so large a star. This may be due to its color, which is yellowish white. For half a century, from 1844 until 1896, Procyon presented a curious problem on account of its slight, yet measurable, changes of position. These changes were ascribed by their discoverer, Bessel, to the presence of a massive invisible companion, but the nineteenth century was in its last pentad when Schæberle, at the Lick Observatory, for the first time caught sight of the mysterious attendant. The spectrum of Procyon places it between Sirius and the sun in the order of stellar evolution. Procyon is in the hind quarter of the Lesser Dog, while Gomeiza and its two fifth-magnitude companions mark the animal's head. The traditional figure of Canis Minor represents it as a well-trained house or watch dog, in contrast with the fierce aspect of Canis Major rearing on his hind legs with Sirius blazing in his wide-stretched jaws.

The name Procyon—from the Greek *προ* and *κύων*, means the "Dog Before"—*i.e.*, before Sirius; for, on account of its greater northern declination, it rises

a little ahead of Canis Major. In the valley of the Euphrates it seems to have been regarded as a water-dog on account of its standing on the border of the Milky Way, the river of the sky. For some reason known only to themselves, astrologers connect this constellation, and particularly Procyon, with good-fortune and the possession of wealth.

The companion of Procyon is of the ninth magnitude, and distant only 4″.46 in 1905, so that but a few of the most powerful telescopes can show it. The two form a binary system with a period of revolution of about forty years. Their actual distance apart is only as great as that between the sun and the planet Uranus. A little telescopic star about ten minutes of arc east of Procyon is double; magnitudes, seventh and eighth; distance, 1″.2.

Gemini

(CHARTS V AND IX)

On the meridian northwest of Canis Minor shine the twins, Gemini, the fourth constellation of the zodiac, Taurus being the third. The two chief stars, Castor and Pollux, are popularly supposed to be equal, and often they are both spoken of as belonging to the first magnitude. In reality there is a decided difference between them. Castor, bearing the Greek letter name Alpha (α), and therefore ranking as the leading star of the constellation, is about halfway between the first and second magnitudes, while Pollux, Beta (β), is but little less than the first. Within the last three hundred years either Castor

has faded or Pollux has brightened, so that the order of their actual brightness has been reversed. There is a striking difference of color between them, Castor being white and Pollux pale orange. From the remotest antiquity these stars seem to have impressed all beholders with the idea of a sort of fraternal relationship. Their distance apart, about five degrees, is not too great for them to resemble a pair, significantly placed with regard to each other, and when their magnitudes were equal this impression must have been yet stronger.

The Twins stand with their feet in the Milky Way, and their heads in the clear space northeast of its borders. The eye readily notices two or three rows of stars crossing the constellation, nearly parallel with the line joining Castor and Pollux. The middle row has a third-magnitude star at each end, the lower one, Delta (δ), also called Wasat, being in the right arm of the twin named Pollux, and the upper one, Theta (θ), in the out-stretched left hand of his brother Castor. Another third-magnitude star, Epsilon (ϵ), in Castor's left thigh, makes an obtuse triangle with Delta and Theta. The star Zeta, in the right thigh of Pollux, is variable, changing from between the third and fourth to between the fourth and fifth magnitudes. The brightest star in the constellation, after the two leaders, is Gamma (γ), or Almison, in the left foot of Pollux. Castor's left foot and ankle are marked by the stars Eta (η), or Propus, and Mu (μ), both of the third magnitude.

Gemini has one star of the first magnitude, two of the second, four of the third, six of the fourth,

and thirteen of the fifth. Sixth-magnitude stars are numerous, four of them making a striking row between Gamma (γ) and Lambda (λ), which is extended eastward beyond Lambda by three others, with a fifth-magnitude one in their string.

> Fair Leda's twins, in time to stars decreed,
> One fought on foot, one curbed the fiery steed.
> —*Dryden's Virgil.*

The heroes Castor and Pollux are among the most interesting figures in Greek mythology, and they so fascinated the imagination of the Romans that they adopted them as the celestial leaders of their world-conquering armies. In the chase of the Calydonian boar, in Jason's Argonautic expedition in search of the Golden Fleece, and in many another famous adventure of the demi-gods in Greece, Castor and Pollux took their part, and it was inevitable that they should finally be translated to the stars. According to one legend, they were the brothers of Helen, for whose fair face "the topless towers of Ilium" were burned; according to another, they were the twin sons of Leda and Jupiter. In any event, they were fighters without stint, and that was enough to insure their adoption at Rome as the "Great White Brethren," whose appearance in the thick of a desperate battle more than once restored the courage of both generals and soldiers.

> By many names men call us,
> In many lands we dwell.
> Well Samothracia knows us,
> Cyrene knows us well.

Our house in gay Tarentum
  Is hung each morn with flowers,
High o'er the masts of Syracuse
  Our marble portal towers.
But by the proud Eurotas
  Is our dear native home,
And for the right we come to fight
  Before the ranks of Rome.
—*Macaulay's Battle of Regillus.*

Visitors to Rome to-day admire their colossal figures in the "Dioscuri," on the Monte Cavallo. One among the many legends about these heroes is interesting as indicating that in very ancient times the names of Castor and Pollux may have been applied to other conspicuous stars, one of which (for instance, Vega) rises when the other (for instance, Aldebaran) is setting. This story asserts that at a double wedding-feast the brothers got into a broil with the bridegrooms and killed them while attempting to carry off the two brides. But Castor was mortally wounded in the fray, whereupon Pollux, who possessed the gift of immortality, wished to die also. Jove solved the difficulty by transferring them to the sky, decreeing that while one shone resplendent the other should pass the time in the nether world, and so alternately.

The Twins have from time immemorial been regarded as the sailors' stars. There is a curious reminder of this in the story of St. Paul's voyage to Rome, which was interrupted by the shipwreck at Malta. An Alexandrian ship, which had wintered in the isle, and whose sign, says St. Paul, was Castor

and Pollux, carried the apostle on to the Eternal City. St. Paul's taking the trouble to mention this fact is characteristic of his interest in a wide range of things outside his religion. We know that he had read the astronomical poem of Aratus, for he quoted a line from it in his celebrated oration on Mars' Hill in Athens. Dr. Seiss would persuade us that Gemini was intended to represent the mystic union of Christ and His redeemed. For the Jews they were Simeon and Levi. The Egyptians represented them as the two gods Horus, the Elder and the Younger. They have also been called David and Jonathan, and even Adam and Eve. They have likewise been connected with the St. Elmo's lamps of the sailors. Homer's "Hymn to Castor and Pollux" seems to suggest this imagined connection between these stars and the mysterious mast-head lights:

> When wintry tempests o'er the savage sea
> Are raging, and the sailors tremblingly
> Call on the Twins of Jove with prayer and vow,
> Gathered in fear upon the lofty prow,
> . . . they suddenly appear,
> On yellow wings rushing athwart the sky,
> And lull the blasts in mute tranquillity.
> —*Shelley's translation.*

The two stars were regarded as twins among the aborigines of the South Pacific islands. In Australia they were called the "Young Men," and among the South African Bushmen the "Young Women." For the Assyrians and the Babylonians, independent of the Greek traditions, they were also the Twins.

Castor is a celebrated double-star, one of the first binaries demonstrated to possess orbital motion. The magnitudes are, approximately, second and third; distance in 1907, 5″.5; colors, greenish white and white. The period of revolution is long, estimated all the way between two hundred and fifty and one thousand years. Delta (δ) is double; magnitudes, third and eighth; distance, 7″; colors, yellow and purple. A couple of degrees northwest of the star Eta (η) is a beautiful cluster, No. 1360, which can be seen as a glimmering mass with a good opera-glass. The telescope reveals it as an astonishing assemblage of minute stars of various magnitudes.

Lynx

(CHARTS II, III, AND VI)

North of Gemini, and between the head of Ursa Major, the Greater Bear, and that of Auriga, lies the very inconspicuous constellation of the Lynx. It contains one star of the third magnitude, one of the fourth, and nine of the fifth. It is a modern constellation, invented by Hevelius in the seventeenth century. It has sometimes been called the Tiger. Although so insignificant to the naked eye, it contains a remarkable number of beautiful double and triple stars. The most interesting of these is the star 12, in the eye of the animal. The components are of the sixth, seventh, and eighth magnitudes; distances, 1″.4 and 8″.7. The star 38, in the extreme southeastern part of the constellation, is a fine double;

magnitudes, fourth and seventh; distance, 3″; colors, white and lilac.

North of the Lynx lies a part of Camelopardalis (already described), and the tail of Draco, a constellation which will be described later.

IV

CONSTELLATIONS ON THE MERIDIAN IN MARCH

Cancer

(CHARTS V AND VI)

THE central point in the sky is now occupied by the fifth constellation of the zodiac, Cancer, the Crab. It is not conspicuous, and the line of the meridian is not brilliant, although on either side of it there are beautiful constellations—Auriga, Gemini, and Canis Minor lying near on the west, while Hydra, Leo, and Ursa Major are approaching it from the east.

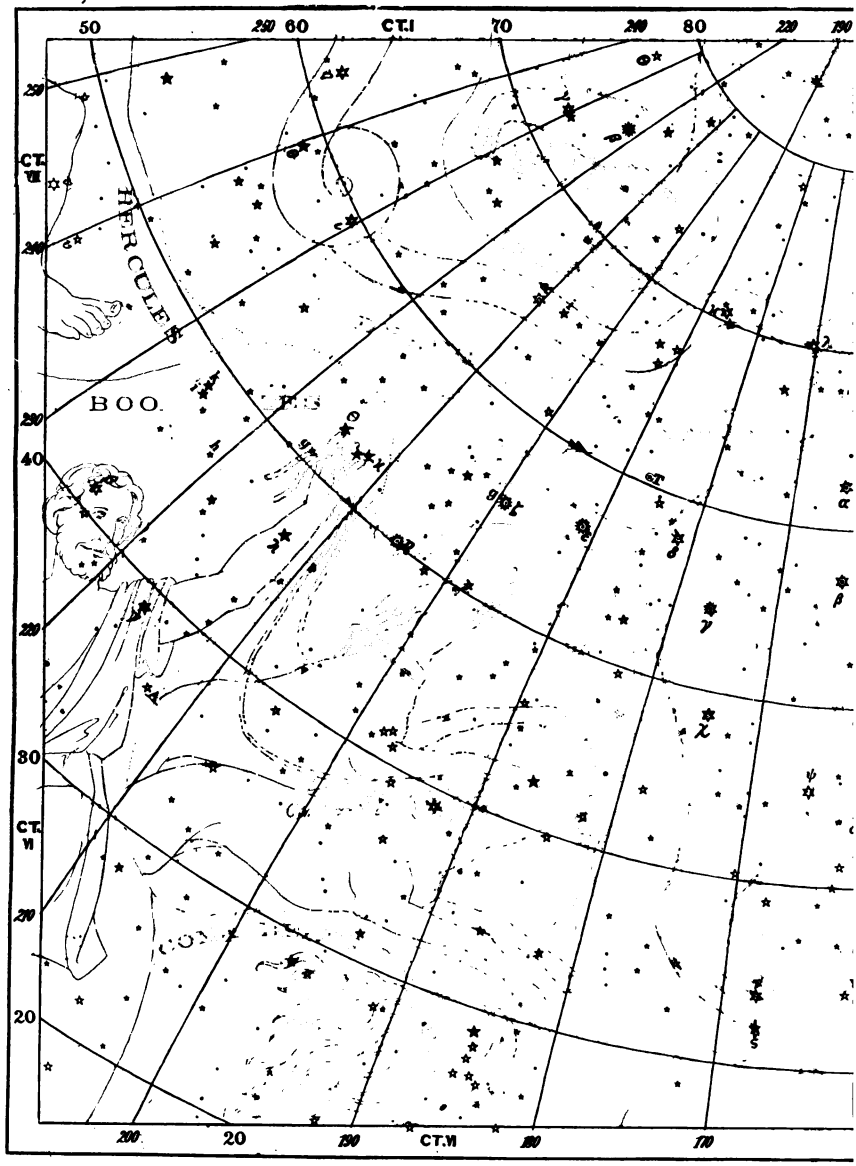
The constellation Cancer is so inconspicuous that one wonders at its antiquity, and at the universal recognition which it seems to have had in all ages. Its position in the zodiac partly accounts for this. It contains no star brighter than the fourth magnitude, and only five of them. Two of these stars, Delta (δ) and Gamma (γ), have been famed from ancient times under the name of the Aselli, or Little Asses. Gamma is the Asellus Borealis, and Delta the Asellus Australis. Nearly between them, a little to the west, gleams a naked-eye cluster of small stars called Præsepe, or the Manger, from which the Aselli

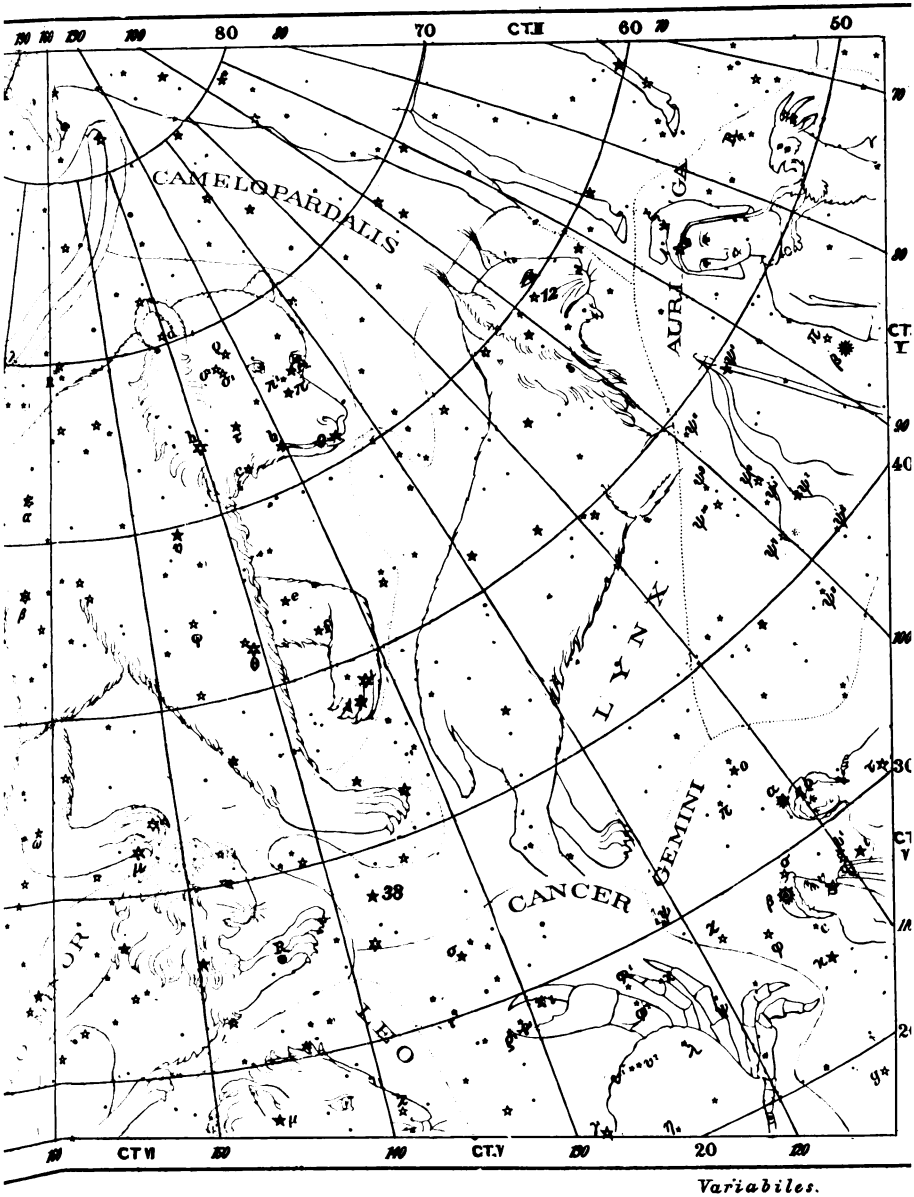
are supposed to feed. The Manger was a celebrated weather portent in the days of Aratus and Homer.

> And watch the Manger. Like a little mist
> Far north, in Cancer's territory, it floats.
> Its confines are two faintly glimmering stars,
> One on the north, the other on the south.
> These are two Asses that the Manger parts,
> Which suddenly, when all the sky is clear,
> Sometimes quite vanishes, and the two stars
> Seem closer to have moved their sundered orbs.
> No feeble tempest then will soak the leas.
> A murky Manger, with both stars
> Unaltered, is a sign of rain.
> If while the Northern Ass is dimmed
> By vaporous shroud, he of the South gleam radiant,
> Expect a south wind. Vapor and radiance
> Exchanging stars, harbinger Boreas.
>
> —*Aratus's Diosemia.*

The dimming of the Manger may truly portend a change of weather, since its stars are so faint that only their number makes them noticeable at all, and the least veil of cirrus at night would hide them before the cloud became sufficiently pronounced to reveal its presence to the eye. Historically the Manger is interesting, because it afforded to Galileo one of his earliest telescopic proofs of the existence of multitudes of stars invisible to the naked eye. In his *Sidereus Nuntius*, containing the original account of his discoveries, he says: "Præsepe is not one star only, but a mass of more than forty small stars. I have noticed thirty-six stars, besides the Aselli, arranged in the order of the accompanying diagram."

$\alpha = 160°$; $\delta = +57°$.

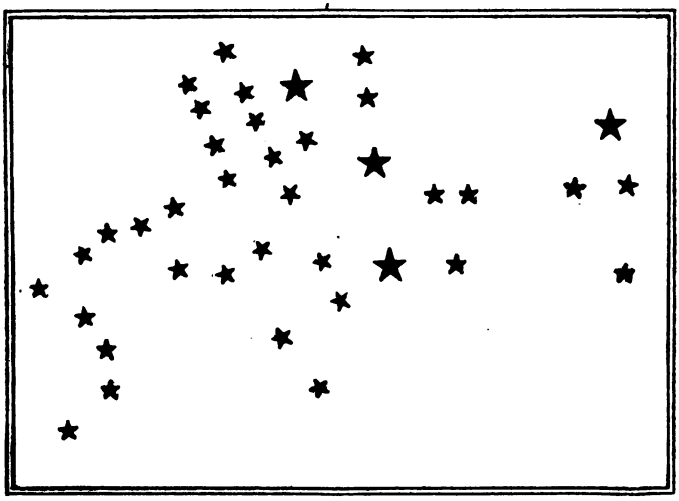




Variabiles.

1m 2m 3m 4m 5m 6m

He then gives the diagram, which is herewith reproduced:



This was a great astronomical discovery in his day, but now anybody possessing a large opera-glass or field-glass can see all that he saw, and even yet many persons, who have never looked at the sky with a telescope, may be almost as much surprised and delighted as Galileo was. An assemblage of stars like this, seen through a glass, always produces a vivid impression which can never be forgotten.

The former Astronomer Royal, Mr. Hind, has recorded another historic event commemorated by the Manger. The most ancient scientific observation of Jupiter that is known to us, he says, was noted by Ptolemy as having occurred eighty-three

years after the death of Alexander the Great, when the planet, happening to pass over the Præsepe cluster, eclipsed the star Delta, or the Asellus Australis.

In English astronomical folk-lore the Manger is called the Beehive, surely a more descriptive name than the other. There are yet two more events in astronomical history connected with this constellation. It was in its neighborhood that the celebrated comet of Halley, the most infrequent in its returns, and the largest of all periodic comets, was first noticed in 1531, and the two supposed intramercurial planets, which the American astronomer Watson imagined that he had discovered during the solar eclipse of 1878, were identified by Professor Peters with the stars Zeta (ζ) and Theta (θ). Formerly the summer solstitial point was situated in Cancer, although now the Precession of the Equinoxes has carried it more than thirty degrees towards the west, but we still speak of the tropic of Cancer.

An ancient Greek myth avers that Cancer represents the Crab that Hera sent to bite the foot of Herakles when he was battling with the Hydra in the Lernæan marshes, but the hero slew the Crab as well as the Hydra, whereupon the goddess induced Zeus to translate the former to the sky. In ancient Egypt this constellation was imagined as a Scarabæus, and regarded as emblematic of immortality. One may wonder how far the ghostly glimmer of the Præsepe cluster contributed to this idea. The astrological significance of Cancer has generally been malign, and Berosus predicted that the earth would

be drowned when all the planets should assemble in this constellation. In that case we seem to have had a narrow escape in June, 1895, for at that time all of the planets, except Neptune, were visible near the Crab. But of course the absence of Neptune, as god of the sea, was fatal to the combination. There could not well be a universal flood with him left out of the conspiracy. Mr. Allen says that one of the Chinese names for this constellation was the Red Bird, supposed to mark one of the residences of the Red or Southern Emperor. Præsepe has been regarded as representing the Manger in which Christ was born. The Jews referred the constellation to Issachar. Dr. Seiss likes the mystic idea of the Egyptians, only he thinks that they were handling a prophecy which they did not understand. Their Scarabæus was a symbol of the Christian resurrection.

Zeta (ζ) is a celebrated quadruple star; magnitudes, sixth, seventh, six-and-a-half, and seven-and-a-half; distances, 1″.16, 5″, and 6″.18, in 1907. There is a complicated set of revolutions effected by these stars around their several centres of gravity. Iota (ι) is double; magnitudes, four-and-a-half and six-and-a-half; distance, 30″.

Hydra

(CHARTS IX AND X)

Under Cancer, and just north of the celestial equator, is a conspicuous pentagon of stars marking the head of Hydra, a very long constellation which occupies four months in crossing the meridian, the

tail arriving upon that line at 9 P.M. in the middle of June. But, upon the whole, it is best, perhaps, to include the description of this constellation in the present chapter. The total length of Hydra, about a hundred degrees, is less than that of Eridanus, but it appears much longer because, unlike the great "river," it does not turn back upon its course. Two of the stars in the Head of this immense Sea Monster, Zeta (ζ) and Epsilon (ϵ), are of the third magnitude, one, Delta (δ), of the fourth, and three of the fifth. The lucida of the constellation, Alpha (α), or Alphard (also Cor Hydræ), is of the second magnitude. It is in line with the eastern edge of Cancer and below the forepaws of Leo. In its comparatively lone situation it is fairly conspicuous, made more so, perhaps, by its orange-yellow color. From this point the constellation, marked with third, fourth, and fifth magnitude stars, often arranged in striking pairs, winds eastward under Leo, Sextans, Crater, Corvus, and Virgo, the tail ending near a bright star in the uplifted claw of Scorpio. After the eye has once traced out the course of Hydra the image of a serpent is not difficult to recognize. Nearly all of the bright stars of the constellation are included in the figure as it is usually drawn. Hydra, facing westward, seems to be contemplating an attack upon Canis Minor, just ahead of him, and standing apparently upon the back of Monoceros. It has sometimes been called Draco, but that name is reserved for the great dragon that curls about the northern pole of the heavens.

In Greek mythology this was the Lernæan monster

destroyed by Herakles. It was fabled to have a hundred heads, and those who sought to destroy it found that if they cut off one, two grew in its place while they were occupied with a second. Herakles got over the difficulty, at the suggestion of Iolaus, by searing the stumps with a hot iron as fast as the heads were severed—an excellent plan for other Hydras.

> Art thou proportioned to the Hydra's length,
> Who from his wounds received augmented strength?
> He raised a hundred hissing heads in air;
> When one I lopped up sprang a dreadful pair.

The Egyptians at one time regarded this constellation not as a serpent but as the celestial counterpart of the Nile. It has also been identified with the dragon of the Argonautic expedition, but that is generally regarded as being represented by the Draco of the North Polar region. Dr. Seiss avers that Hydra stands for "the Great Dragon, that old Serpent, called the Devil, and Satan, which deceived the whole world" (see Revelations xii.), and earlier constructors of Biblical symbols among the stars regarded this constellation as representing the Flood, while Corvus, the Raven, standing on its back, was the bird sent out by Noah.

Epsilon (ϵ) is a remarkably beautiful double; magnitudes, fourth and eighth; distance, 3″.4; colors, yellow and blue. Theta (θ) is double; magnitudes, fourth and twelfth; distance, 50″.

Underneath the Head of Hydra, extending down to the southern horizon, is a relatively barren region,

covered by a part of the constellation Argo Navis. Turning to the region north of Cancer, near the line of the meridian, we find before reaching the Pole Star only the hind quarters of the Lynx, the fore-paws and head of Ursa Major, and the head of Camelopardalis, which have already been described or will be described later.

V

CONSTELLATIONS ON THE MERIDIAN IN APRIL

Leo

(CHART VI)

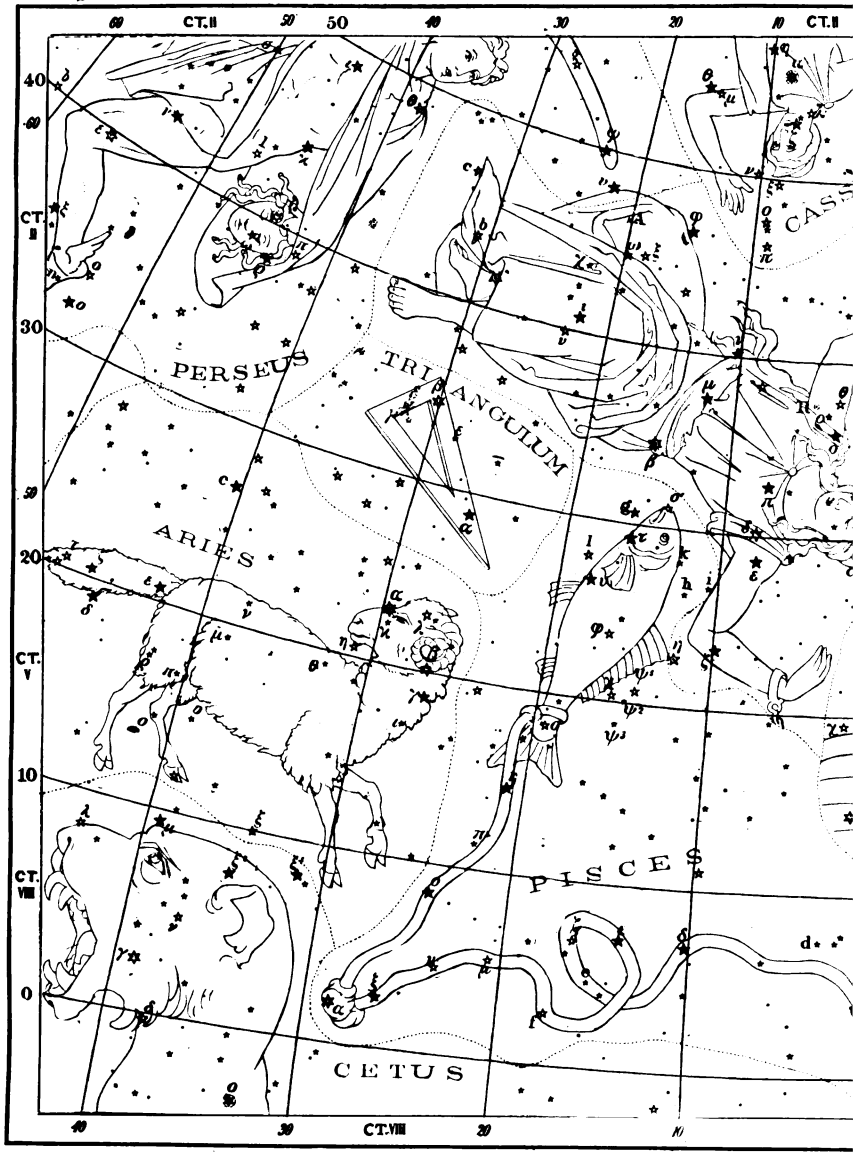
LEO, the great Lion of the sky, now reigns supreme, king of celestial as of terrestrial beasts. Leo is the sixth constellation of the zodiac, and one of the most clearly marked on account of the figure of a large sickle, with its handle downward and its curving blade open towards the west, which occupies the western part of the constellation, including the head and fore quarters of the Lion. At the end of the handle of this sickle glows the principal star of the constellation, Regulus, or Alpha (α), usually ranked as of the first magnitude, but in reality of less than the standard brightness. Still, Regulus is a conspicuous and beautiful star, and, lying very close to the ecliptic, it is sometimes occulted by the moon.

This star has been famous in all ages. Copernicus bestowed upon it the name it now bears, a diminutive form, says Mr. Allen, of the earlier name Rex, which arose from the ancient belief that it ruled the affairs of heaven. In English it has often been called the Royal Star. In Persian uranography it was one

of four Royal Stars, the "Four Guardians of Heaven," the others of which have been identified with Fomalhaut, Aldebaran, and Antares. These marked the four cardinal points, Regulus standing for the South, Fomalhaut for the North, Aldebaran for the East, and Antares for the West. As they are about six hours of Right Ascension apart, and all very conspicuous, their selection for this purpose was not unnatural. With the exception of Fomalhaut, they all lie quite close to the ecliptic, the annual path of the sun.

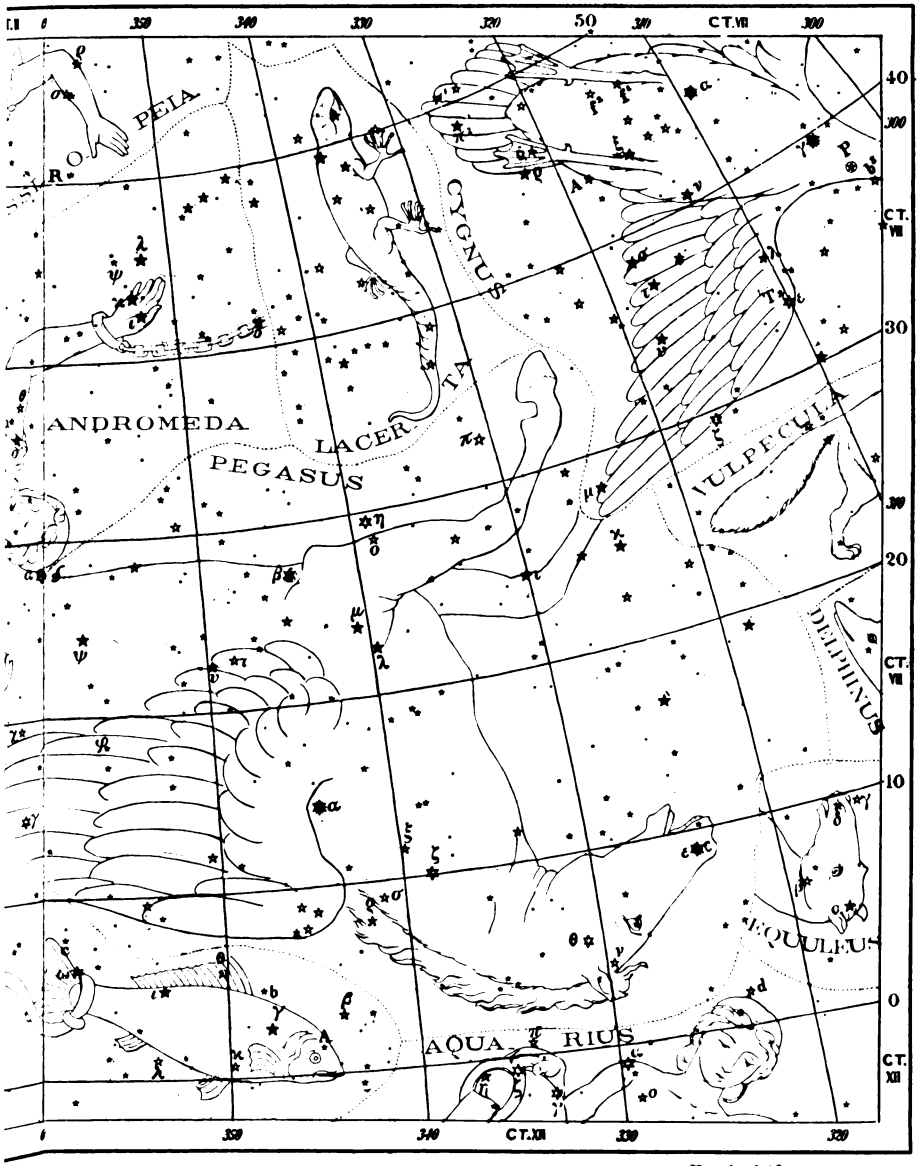
Regulus shines near the heart of Leo, and accordingly is sometimes spoken of as the Lion's Heart. The second star of the constellation lies far away to the east in the end of the tail. It is called Denebola, or Beta (β), and is of the second magnitude. Five other stars besides Regulus constitute the figure of the sickle already spoken of. One of these, Gamma (γ), Algieba, is of the second magnitude; three, Eta (η), Zeta (ζ), and Epsilon (ϵ), are of the third magnitude; and one, Mu (υ), of the fourth. Gamma is a beautiful double, and is also interesting for lying close to the radiant point of the great November meteor shower, which was so brilliant in 1833 and 1866. These stars lie in the mane and head of the Lion, Lambda (λ), a little west of Epsilon (ϵ), being in the open jaws. Regulus, Gamma, Denebola, and Delta mark the corners of a conspicuous quadrilateral which covers the whole central part of the constellation. Both Regulus and Denebola, by their spectra, belong to the Sirian order of suns—that is to say, they are younger than our sun.

$\alpha = 0^{\circ}$, $\delta = +28^{\circ}$.



1ª 2ª 3ª 4ª 5ª 6ª

Chart IV



ANDROMEDA
PEGASUS
LACERTA
CYGNUS
VULPECULA
DELPHINUS
EQUULEUS
AQUARIUS
CT. VII
CT. XII
Variabiles.
1m 2m 3m 4m 5m 6m

Nearly all of the old nations saw a lion in this constellation. According to the Greeks, it was the celebrated Nemæan Lion slain by Herakles. In India and in Egypt it was always represented in the zodiacs by the figure of a lion. It was associated with the great heat of summer, and Burritt remarks:

> The Egyptians were much annoyed by lions during the heat of summer, as they at that season left the desert and haunted the banks of the Nile, which had then its greatest elevation. It was therefore natural for their astronomers to place the Lion where we find him in their zodiac.

The Lion was the symbol of the tribe of Judah, and the constellation is found in the Hebrew zodiac, where it is the twelfth or last sign instead of the fifth. Allen calls attention to a remark of Landseer that the association of Leo with Judah arose from the fact that Leo was Judah's natal sign, and as such was borne on the signet ring which he gave to Tamar. In the Middle Ages Leo was identified with Daniel's lion. Dr. Seiss develops in detail the connection of Leo with the lion of the tribe of Judah, and, referring to the Apocalypse, he says that "what is thus pictured in the last book of the Scriptures is the same that was fore-intimated and recorded in this last sign of the zodiac before any one book of our present Bible was written." As in China everything goes by contraries, the Lion of the zodiac was there regarded as a Horse. Regulus has always been a fortunate star with the astrologers, while Denebola, at the other end of the constellation, is an unfortunate

one—a very even-handed distribution of powers for one constellation.

Regulus has at a distance of three minutes of arc a faint companion star which, it has been said, looks as if it had been steeped in indigo, and which is double; magnitudes, eight-and-a-half and thirteenth; distance, 3″.3. Gamma is one of the most charming doubles in the sky; magnitudes, second and fourth; distance, 3″.6; colors, orange and green. These colors are pronounced. Iota is double; magnitudes, fourth and eighth; distance, 2″.2; colors, lemon yellow and light blue. The variable star R is remarkable. Its color is deep red, and in the space of three hundred and twelve days it changes from the fifth magnitude to the tenth, and back again. Consequently for a part of the time it is entirely absent from the sky, as far as naked-eye observation is concerned. Being at a maximum about January 20, 1908, future periods of visibility of this star may be predicted from its periodic time.

Leo Minor

(CHARTS III AND VI)

This is a small constellation lying north of Leo and under the hind feet of Ursa Major. The Lesser Lion is inconspicuous to the eye, and possesses no mythology, having been invented by Hevelius in the seventeenth century. It contains only three stars as bright as the fourth magnitude and six of the fifth magnitude. It is almost equally uninteresting for telescopic observation.

CONSTELLATIONS IN APRIL

Ursa Major

(CHARTS I, III, AND VI)

Directly north of Leo Minor is one of the great figures of uranography, and one of the most familiar to ordinary observation of all the constellations—Ursa Major, the Greater Bear. Indeed, on account of its situation within about forty degrees of the north polar-star, Ursa Major is probably oftener seen and recognized in the heavens than any other group of stars. It is especially known by the celebrated figure of the Great Dipper, formed by seven stars in the flank and tail of the Bear. In the latitude of New York the Great Dipper never sets, the star in the extreme end of the long handle just skimming the horizon in the evenings of November and December, while in May and June it is almost overhead.

There is no other figure among the stars so well marked as this, unless it may be the Northern Cross in Cygnus, or the Northern Crown. But the Great Dipper is far more conspicuous than either of these. Six of its seven stars are of the second magnitude, and one of the third.

In the middle of the handle is a famous naked-eye double, Mizar, whose companion, close by on the northeast, is named Alcor. These stars are sometimes called the Horse and Rider. Any good eye can easily separate them, and yet they were at one time regarded as a test of naked-eye seeing.

The Great Dipper has had many names, among them being Charles's Wain, and the Plough, the popu-

lar title in England. Mr. Allen has shown how the name Charles's Wain (meaning wagon) is derived from an earlier title which made it Charlemagne's Wain. The courtiers of King Charles I. of England connected it with his name:

> . . . those bright stars
> Which English shepherds Charles's Wain do name,
> But more this isle is Charles's wain,
> Since Charles her royal wagoner became.
> —*John Taylor* (1630).

The use of this asterism as a timekeeper is vividly illustrated by Shakespeare in the scene between the carriers in the inn-yard at Rochester, in "King Henry IV.," Part I., Act II., Scene I.:

> Heigh-ho! an' it be not four by the day, I'll be hanged: *Charles's Wain* is over the new chimney, and yet our horse is not packed!

In earlier England it was called Arthur's Wain. In America the seven stars of the Dipper have sometimes borne the pleasing title of the Seven Little Indians, and I recall from boyhood days, in the Mohawk Valley, this doggerel, which was sung to a childish air:

> One little, two little, three little Injuns,
> Four little, five little, six little Injuns,
> Seven little Injun boys.
> Seven little, six little, five little Injuns,
> Four little, three little, two little Injuns,
> One little Injun boy.

I do not know whether the Indians had any legend about the seven stars, but the Algonquins called the

whole constellation the Bear and Hunters. The name Plough, so popular in England, is of classic origin, the Romans having known the Dipper as the Triones, or Oxen, which were figured as drawing a plough. These became with later writers the Septentriones, as in Virgil.

For the people of the far North, the Laplanders, the stars of the Dipper represent a reindeer. The name Seven Stars has often been given to the Pleiades, but, as Mr. Allen remarks, seems more appropriate when applied to the stars of the Dipper, on account of the conspicuousness of the latter. They have been called, variously, the Seven Wise Men of Greece, the Seven Sleepers of Ephesus, and the Seven Champions of Christendom.

The individual names of these stars, beginning with the northwestern corner of the bowl of the imaginary dipper, are Dubhe, Merak, Phaed, Megrez (the faint one), Alioth, Mizar (before mentioned with its companion, Alcor), and Benetnasch. Their Greek letter names, in the same order, are Alpha (α), Beta (β), Gamma (γ), Delta (δ), Epsilon (ϵ), Zeta (ζ), and Eta (η). Alpha and Beta, the pair in the outer side of the bowl, are often called the Pointers, because an imaginary line drawn through them and extended polewards nearly hits the pole-star at a distance of about thirty degrees. These seven stars differ in color, although the fact may not be apparent to hasty observation. Alpha and Gamma are yellow, Beta is greenish, and Zeta and Eta are brilliant white. Delta, now so much fainter than its sisters that one feels a certain disappointment over the irregularity which

it introduces into an otherwise perfect array of equal stars, seems formerly to have been as bright as any of them, and, in his time, Tycho Brahe, the famous Danish astronomer, estimated it of the second magnitude, like the others. It is probably a long-period variable.

The idea of dancing was connected with Ursa Major, as well as with the other circumpolar constellations, by the ancients. Sir G. C. Lewis says that this was derived from the circular dances of the Greeks. The two bears (Ursa Major and Ursa Minor) were imagined reeling round the pole like a pair of waltzers:

> Onward the kindred Bears, with footsteps rude,
> Dance round the pole, pursuing and pursued.
> —*E. Darwin.*

The mythology of Ursa Major is intimately associated with that of Ursa Minor (see Chapter VII.), and together they have furnished more poetic suggestions to the literature of many nations than any half-dozen of the other constellations. The ceaseless tread of the Bears, keeping guard round the north pole, naturally appeals to the popular imagination. Ursa Major was fabled to be Helice, or Callisto, a princess of Arcadia, who, having offended Hera by attracting the attention of the ever-amorous Zeus, was turned into a bear:

> . . . her hand within her hair she wound,
> Swung her to earth and dragged her on the ground.
> The prostrate wretch lifts up her hands in prayer;
> Her arms grow shaggy and deformed with hair,

Her nails are sharpened into pointed claws,
Her hands bear half her weight, and turn to paws,
Her lips, that once could tempt a god, begin
To grow distorted in an ugly grin.
—*Ovid's Metamorphoses.*

After this painful tragedy of female jealousy, Jove, with his usual regard for his friends, translated poor Helice to the sky and bestowed upon her the immortality of the stars. The extreme and very unbear-like length of Ursa Major's tail has always been a subject of pleasantry, and Mr. Allen quotes a quaint explanation suggested by Dr. Thomas Hood early in the seventeenth century:

Imagine that Jupiter, fearing to come too nigh unto her teeth, layde holde on her tayle, and thereby drew her up into the heaven, so that shee of herself, being very weightie, and the distance from the earth to the heavens very great, there was great likelihood that her taile must stretch. Other reason know I none.

In Scandinavia Ursa Major was Thor's Wagon, and also the Wagon of Odin, Thor's father. Among the Hebrews the constellation was regarded as a bier, or coffin, and the early Christians called it the Bier of Lazarus. In the Middle Ages it was regarded by some as one of the bears sent by Elisha the prophet to devour the mocking boys. Dr. Seiss regards it as symbolical of the heavenly Sheepfold, and he manages to derive the name Callisto from a Semitic root meaning a sheepfold, or enclosure.

Ursa Major has six stars of the second magnitude; eleven of the third; three of the fourth; forty of the

fifth, and a great number of the sixth. The three pairs in the feet are conspicuous.

The star Zeta (ζ), or Mizar, has already been described as a naked-eye double. The larger star is again doubled in the telescope, presenting a very charming spectacle; magnitudes, second and fourth; distance, 14″.5; colors, white and emerald. The larger star of this pair is a close spectroscopic binary. Zeta is also interesting as the first telescopic double ever observed. Riccioli detected its duplicity in 1650. The star Xi (ξ), in the right hind-foot, is double; magnitudes, fourth and fifth; distance, 2″.5. The star Sigma (σ) is double; magnitudes, fifth and eighth; distance, 2″.6.

Sextans

(CHARTS VI AND X)

Between Ursa Major and the north pole winds the body of Draco, which will be described in a subsequent chapter. We turn now to the neighborhood of the meridian south of Leo. Directly underneath the Sickle of Leo is the small constellation Sextans, the Sextant. This is one of the seventeenth-century constellations formed by Hevelius from star spaces, either left out of their constellations by the ancients, or apparently useless to them, and consequently regarded as a kind of "public land," which the first settler could seize. Hevelius was not unmindful of his own glory in this case, since he formed the constellation to immortalize the sextant used by him in his stellar observations. Admiral Smyth says that Hevelius put the Sextant between Leo and Hydra

because those constellations, according to the astrologers, were of a fiery nature, and he wished to commemorate the fire which destroyed his house and his instruments at Dantzic in 1679. After a couple of thousand years this could be transformed into as good a myth as any, Hevelius becoming a demigod who hunted down celestial monsters and brought order into the sky with a terrible three-bladed weapon more fatal than the Club of Herakles. In the seventeenth century Von Rheita imagined that he saw Saint Veronica's Sacred Handkerchief among the stars out of which Hevelius constructed his Sextant. Sir John Herschel, who was not without humor for an astronomer, remarked concerning Von Rheita's sacred handkerchief that many strange things were seen among the stars before powerful telescopes became common. Sextans contains one star of the fourth magnitude, and four of the fifth.

Crater

(CHART X)

The constellation Crater, the Cup, is represented by an appropriate figure standing on the back of the immense sea-serpent Hydra. Its shape suggests the name by which it has been known from time immemorial. It is usually represented in the form of a large urn, or beaker, tipped towards the east. In China it seems to have been figured as a dog. It contains one star of the third magnitude, Delta (δ), four of the fourth, and two of the fifth. The leading

star, Alpha (α), or Alkes, is not now the brightest. The mythology of this constellation is more interesting than its appearance promises. The Greeks regarded it as the Goblet of Apollo, but Manilius ascribes it to Bacchus:

> Close by the Serpent spreads, whose winding spires
> With ordered stars resemble scaly fires.
> Next flies the Crow, and next the generous Bowl
> Of Bacchus flows, and cheers the thirsty pole.

It was also known as the Cup of Herakles, of Achilles, of Dido, and of Medea. Later it was identified with the cup that Joseph found in Benjamin's sack, and with Noah's wine-cup. Dr. Seiss gives it a tragic turn, and ominously calls it the Cup of Wrath of the Revelations: "Dreadful beyond all thought is the picture John gives of this cup of unmingled and eternal wrath, but not a whit more dreadful than the picture of it which the primeval prophets have thus inscribed upon the stars."

It must be confessed that the good doctor's imagination is vivid, for Crater is a very inoffensive-looking constellation, much more suggestive of Bacchus than of wrath.

VI

CONSTELLATIONS ON THE MERIDIAN IN MAY

Corvus

(CHART X)

DIRECTLY east of Crater, and also standing on the back of Hydra, is Corvus the Crow. Four bright stars, marking out an irregular quadrilateral, make this constellation conspicuous. Three of these stars, Beta (β), Delta (δ), or Algorab, and Gamma (γ), or Giena, are of the second magnitude. The fourth, Epsilon (ϵ), is of the third magnitude, while Alpha (α), or Al Chiba, the leader of the constellation, situated below Epsilon, is only of the fourth magnitude. It was probably brighter in ancient times, for it bears the name which the Arabs, according to Mr. Allen, gave to the entire constellation. A fifth-magnitude star, Eta (η), makes a striking naked-eye pair with Delta. Alpha is in the beak of the bird, which is represented pecking at the scales of Hydra:

> A phantom Crow that seems to peck her spires.
> —*Aratus.*

The ancient Akkadians seem to have regarded this constellation as representing a horse, but nearly all

the other ancients saw a bird there. With the Chinese it was the Red Bird, with the Romans and the Hebrews the Raven, and in the valley of the Euphrates it may, according to Mr. Allen's interpretation of an ancient tablet, have been called the Great Storm Bird, or the Bird of the Desert, connected with the myth of Tiamat. Among the Greeks, Apollo was credited with having placed this bird among the stars, as usual in such cases, for services rendered in an amorous adventure. Becoming suspicious of the beautiful Coronis, the mother of Æsculapius, the god sent a crow to watch her. The testimony of this winged detective led to the death of Coronis by an avenging arrow, and to the translation of the tell-tale bird to the sky. Corvus is Dr. Seiss's Bird of Doom, indicating by his attack on Hydra, the Fleeing Serpent, the final overthrow of the Evil One.

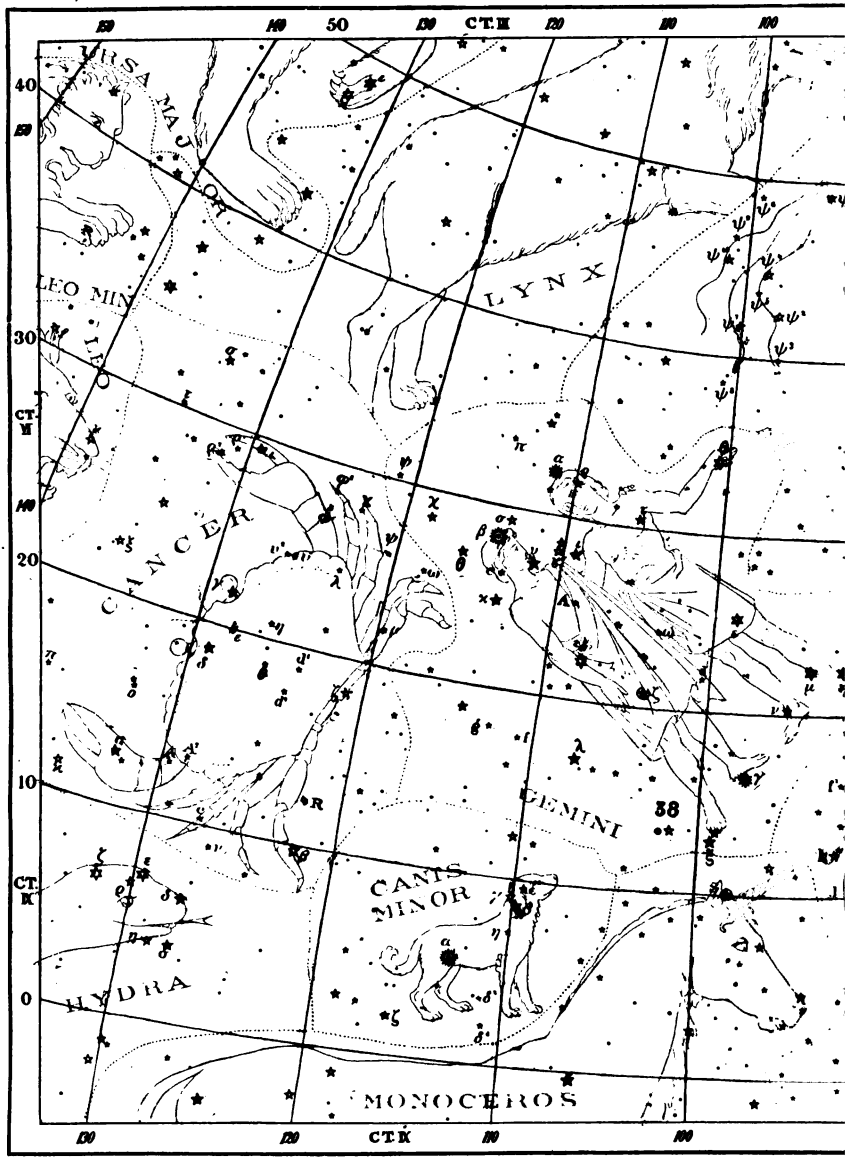
Virgo

(CHARTS VI AND X)

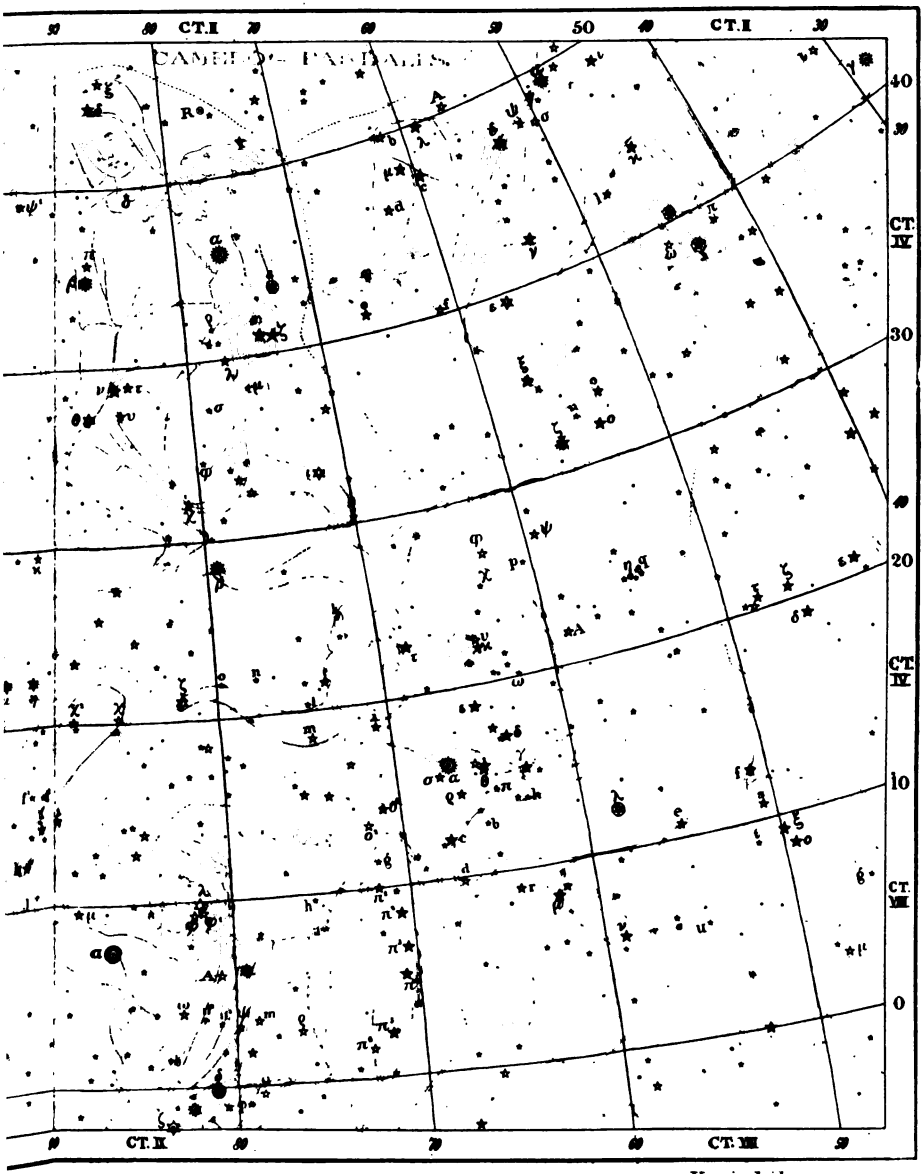
North of Corvus, but extending far beyond the eastern limit of that comparatively small constellation, is Virgo, the seventh constellation of the zodiac, which contains one of the most beautiful of all the first-magnitude stars, Spica, or Alpha (*a*) Virginis.

No one can familiarize himself with the stars without insensibly choosing favorites among them. Spica has long been one of my favorites, not because of extraordinary brilliancy, for it has not the full brightness of the first magnitude, but rather because of the

$\alpha = 90°$, $\delta = +28°$.



1ª 2ª 3ª 4ª 5ª 6ª


CT. I
CT. II
CT. III
CT. IV
CT. V
CT. VI
CT. VII
CT. VIII
CT. IX
CAMELOPARDALIS
Variabiles.

singular purity of its white rays, and because of its association with the opening of spring. Its situation in the sky is also such as to attract and please the eye. There is no other star of anything like equal brightness within thirty degrees of it. Spica, together with Denebola in the Lion's tail, Arcturus in Boötes, and Cor Caroli in Canes Venatici, form the celebrated "Diamond of Virgo," a geometrical figure fifty degrees in its greatest length and very striking when once the eye has traced it out. Historically Spica is very interesting, as having, together with Regulus in Leo, furnished to Hipparchus the data which enabled him to discover the Precession of the Equinoxes. It belongs to the first, or youngest, order of suns, together with Sirius, Rigel, and Vega. Like them, too, it is a sun of enormous magnitude. It is one of the spectroscopic binaries, the period of revolution being only four days.

Virgo, the Virgin, has been the name of this constellation among all peoples and in all parts of the world, even in China, where she was called the Frigid Maiden. As generally drawn by the makers of constellation figures, she carries a head of wheat in her left hand, and here shines Spica, a name signifying a wheat ear. She has folded wings springing from her shoulders, the star Beta (β), or Zavijava, marking the top of the left wing. Three fourth, one fifth, and two sixth magnitude stars indicate the head. The star Eta (η), or Zaniah, of the third magnitude, is in the heart. Gamma (γ), or Porrima, of the third magnitude, shines on the girdle. Theta (θ), Zeta (ζ), and Delta (δ) are spangled upon the drapery. Theta

is of the fourth and the others of the third magnitude. Epsilon (ϵ), or Vindemiatrix, of the third magnitude, shines in the right wing. The name means "grape-gatherer," and originated from the fact that this star was seen rising before the morning sun at the beginning of the vintage. The stars Lambda (λ), Pi (π), and Iota (ι) are in the Virgin's feet. There are about a dozen fairly conspicuous stars belonging to the constellation which are not included in the figure. Altogether Virgo contains one star of the first magnitude, six of the third, nine of the fourth, and seventeen of the fifth. The sixth-magnitude stars are very numerous, a striking band of them running down the middle of the drapery below the girdle and above Spica.

Virgo is a mine of beautiful myths. Mr. Andrew Lang has shown that the old English "Kern-baby," made up of the last gleanings of the harvest, and escorted with music from the field, recalls the harvest goddess of ancient Peru and a similar divinity of Sicily, who was identical with Persephone, the daughter of Demeter, the goddess of the corn. Georgius Cæsius, in the sixteenth century, beautifully imagined the classic Virgo as Ruth gleaning in the fields of Boaz. Mr. Allen recalls an old custom of La Vendée, where the farmer's wife, under the name of the Corn Mother, is tossed in a blanket at the end of the harvest to bring good-luck at the threshing. All of these popular customs are directly associated with the myths concerning the constellation Virgo.

Hesiod identified Virgo with Astræa, the Goddess of Justice, who ruled the world in the Golden Age. As

mankind passed in succession through the Silver and the Bronze ages to the terrible Age of Iron, all the gods and goddesses one by one quitted the earth, but Astræa lingered until the last. When she could no longer endure the brutal scenes and passions displayed around her, "loathing that race of men," she

> Winged her flight to heaven,
> Where still by night is seen
> The Virgin goddess near to bright Boötes.
>
> —*Aratus.*

The Romans had an equally exalted opinion of the character of Virgo:

> But modest Virgo's rays give polisht parts,
> And fill men's breasts with honesty and arts;
> No tricks for gain, nor love of wealth dispense,
> But piercing thoughts and winning eloquence.
>
> —*Manilius.*

Another Greek legend associated Virgo with Erigone, the unfortunate daughter of Icarius, the Athenian who enjoyed the friendship of the god Bacchus. The god fell in love with Erigone, but this honor—which was not, to be sure, a very singular one—did not deter her from hanging herself for grief over the murder of her father. Mr. Allen, whose suggestions are always interesting, supposes that the name Erigone may have been derived from the Homeric Ἠριγένεια, the Early Born, the constellation being a very old one. In Egypt, Virgo was identified with Isis, and it was said that she had made the Milky Way by dropping wheat-heads. In the valley of the Euphrates she

seems to have been associated with Ishtar, the Queen of the Stars, turned, says Allen, into the Ashtoreth of the Book of Kings, the Astarte of Syria, the Hathor of Egypt, and the Aphrodite of Greece. In Assyria she was Bel's wife. In Judea her name was Bethulah, and she was regarded as giving abundant harvests. Dr. Seiss, as we might anticipate, identifies her with the Virgin Mary. The same thing was done by the churchmen of the Middle Ages.

Scattered over the area between the stars Beta, Eta, Gamma, Delta, and Epsilon lies the celebrated Field of the Nebulæ, thus called on account of the surprising assemblage of faint telescopic nebulæ to be seen there. They number more than three hundred! Nebulæ are the seeds of future suns, and, remembering this fact, one cannot help being impressed by the singular choice of Virgo as the celestial patron of husbandry, a choice made thousands of years before the invention of the telescope or the discovery that such things as nebulæ existed. Was there once a now forgotten age when men were as learned as we are to-day, and did a little of this knowledge descend to their degenerate successors in the form of uncomprehended traditions? Another thing which associates the Field of the Nebulæ with the ideas of seed-time and harvest, of growth, life, and development, is the presence in the same area of an extraordinary number of variable stars.

Among telescopic objects may be mentioned the star Gamma, one of the most celebrated of visual binaries. In brightness the two components are nearly equal, both being usually reckoned of the third

magnitude. The distance between them is variable, since they revolve around their common centre of gravity in a long period, which may be as much as a hundred and seventy years. In 1836 they were so close that no telescope could split them. In 1904 their distance was 5″.8. In 1931 their distance should be over 6″, and after that, if the period mentioned is correct, they will begin to close up again. Theta is double; magnitudes, fourth and ninth; distance, 7″. There is a third faint star at a distance of 65″.

Coma Berenices

(CHARTS III AND IV)

North of Virgo, directly on the meridian in the middle of May, and almost exactly overhead in the mean latitude of the United States, is the beautiful little constellation of Coma Berenices, or Berenice's Hair. To the eye it appears as a glimmering spot in the sky, and a little attention is needed to reveal the separate stars composing it. There are six of these in a close group in the crown of the chevelure, one of the fourth, and five of the fifth magnitude. There are two other fourth-magnitude and twelve fifth-magnitude stars in the constellation, with many of the sixth magnitude which serve to increase the glimmer. They have no names or letters—only numbers. Yet the constellation is an ancient one. It is situated at the northern pole of the Milky Way. The name is said to be that of Berenice, the queen of Ptolemy Euergetes, and the legend relates that when her husband started on a dangerous campaign into Assyria, Berenice vowed to

dedicate her beautiful hair to the Temple of Venus if he should return safe. He did return, and the queen kept her vow. Then Jove, who was always ready to oblige a beautiful woman, even though she were mortal, translated the shining locks to the stars. Eratosthenes, however, identified the constellation with the hair of Ariadne. In later Christian times it was identified with the sacred handkerchief, the Vera Icon, of Saint Veronica. Dr. Seiss associates it with the Star of the Magi. It was vertically overhead at Jerusalem on the 25th of December at the time of Christ's birth, he says, and he locates the wonderful new star observed by Hipparchus, more than a hundred years before, in this constellation. It was the appearance of this star that led Hipparchus to make his stellar catalogue. Hipparchus lived more than a century before Christ, but Dr. Seiss has found a Chinese reference to the new star as being brilliant at a period corresponding to that of the Saviour's birth. In the days of Ptolemy, a century and a half after Christ, the star was so faint as hardly to be distinguishable. If it was a temporary star, it has not reappeared since.

There is in Coma Berenices a singular collection of double stars with *lilac*-colored companions. I quote, on this subject, from my *Pleasures of the Telescope*:

> Let us begin with the star 2, magnitudes sixth and seven and a half, distance 3″.6. The color of the smaller star is *lilac*. This color, although not extremely uncommon among double stars elsewhere, recurs with singular persistence in this little constellation. In the very next star that we look at, 12, we find a double whose smaller component is *lilac*.

The magnitudes are fifth and eighth, distance 66″. So also the wide double 17, magnitudes fifth and six and a half, distance 145″, exhibits a tinge of *lilac* in the smaller component. The triple 35, magnitudes fifth, eighth, and ninth, distances 1″ and 28″.7, has for colors yellow, *lilac*, and blue; and the double 24, magnitudes fifth and sixth, distance 20″, combines an orange with a *lilac* star.

Canes Venatici

(CHARTS I, II, AND VI)

Between Coma Berenices and the handle of the Great Dipper we find another extremely interesting little constellation—Canes Venatici, or the Hunting Dogs. It has but one star as bright as the third magnitude, the beautiful Cor Caroli, or Charles's Heart, thus named by Halley in honor of King Charles II. of England, because it was said to have shone with extraordinary brilliancy on the night of his coronation. This star is double, having at a distance of 20″ a sixth-magnitude companion of a light-blue or, as some say, lilac hue. The contrast is superb in a small telescope.

But while the principal star of the Hunting Dogs has received a name whose romance is associated with English history, the constellation was invented in Germany by Hevelius He named the two dogs Asterion and Chara, the former being the more northern one. Cor Caroli flames on the collar of Chara. These dogs are represented as a pair of hounds held in a leash by Boötes, and seeming to chase Ursa Major round the pole, whence Carlyle's reference to the dogs

of Boötes running across the zenith "in their leash of sidereal fire." Canes Venatici contains, besides Cor Caroli, one star of the fourth magnitude and seventeen of the fifth. In the head of the dog Asterion, invisible to the naked eye, and revealing its full wonder only in photographs, is the famous Whirlpool Nebula of Lord Rosse.

Some degrees north-northwest of Cor Caroli is a remarkable star, faintly visible to the naked eye, which Secchi named La Superba, on account of its surprisingly brilliant red color. A telescope should be used to appreciate its beauty.

VII

CONSTELLATIONS ON THE MERIDIAN IN JUNE

Libra

(CHARTS X AND XI)

WE begin with the eighth constellation of the zodiac, Libra, the Balance, which at nine o'clock in the middle of June appears just entering upon the meridian from the east, following the feet of Virgo. This constellation was blended by the Greeks with Scorpio, forming the out-stretched claws of that monster. It seems to have been separated from Scorpio, under the name of Libra, in the time of Julius Cæsar. Homer's reference to "golden scales" hung by Zeus in heaven is thought to have been associated with some other group of stars, but Milton places the Balance where we see it in his description of the threatened battle between Gabriel and Satan:

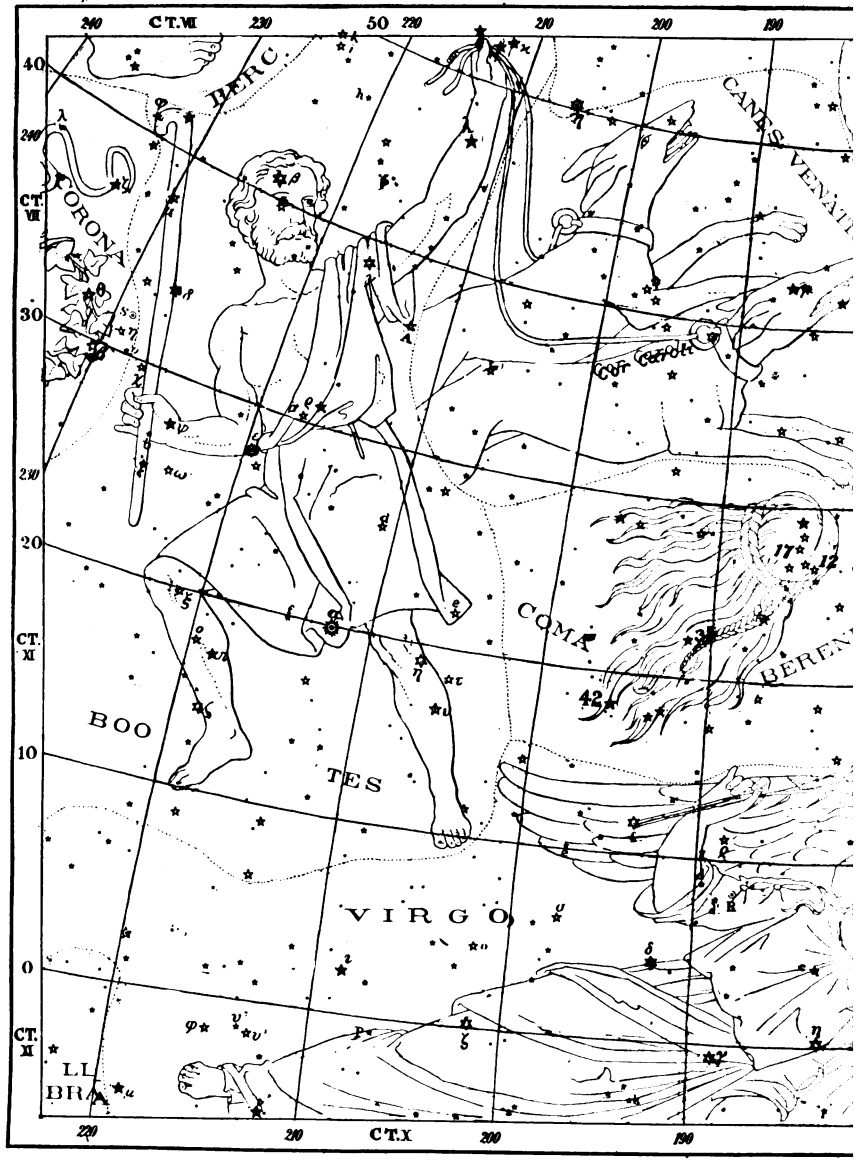
> . . . Now dreadful deeds
> Might have ensued, nor only Paradise
> In this commotion, but the starry cope
> Of heaven perhaps, or all the elements
> At least, had gone to wrack, disturbed and torn
> With violence of this conflict, had not soon

> The Eternal, to prevent such horrid fray,
> Hung forth in heaven his golden scales, yet seen
> Betwixt Astræa and the Scorpion sign.
> —*Paradise Lost, Book IV.*

Astræa here refers to Virgo. Two stars of the second magnitude, Beta (β), or Zubeneschemali, and Alpha (α), or Zubenelgenubi, indicate the two scales of the balance, Beta being the more northern and the brighter. This star is remarkable as the only naked-eye star which has a green color. The hue is sufficiently pronounced to be evident to any sensitive eye. Green is a rare stellar color, except with some of the components of telescopic doubles. Some eyes, however, detect a tinge of green in the rays of Sirius. Alpha has a fifth-magnitude companion easily seen with an opera-glass. Besides its two leading stars, Libra contains one star of the fourth magnitude and nine of the fifth.

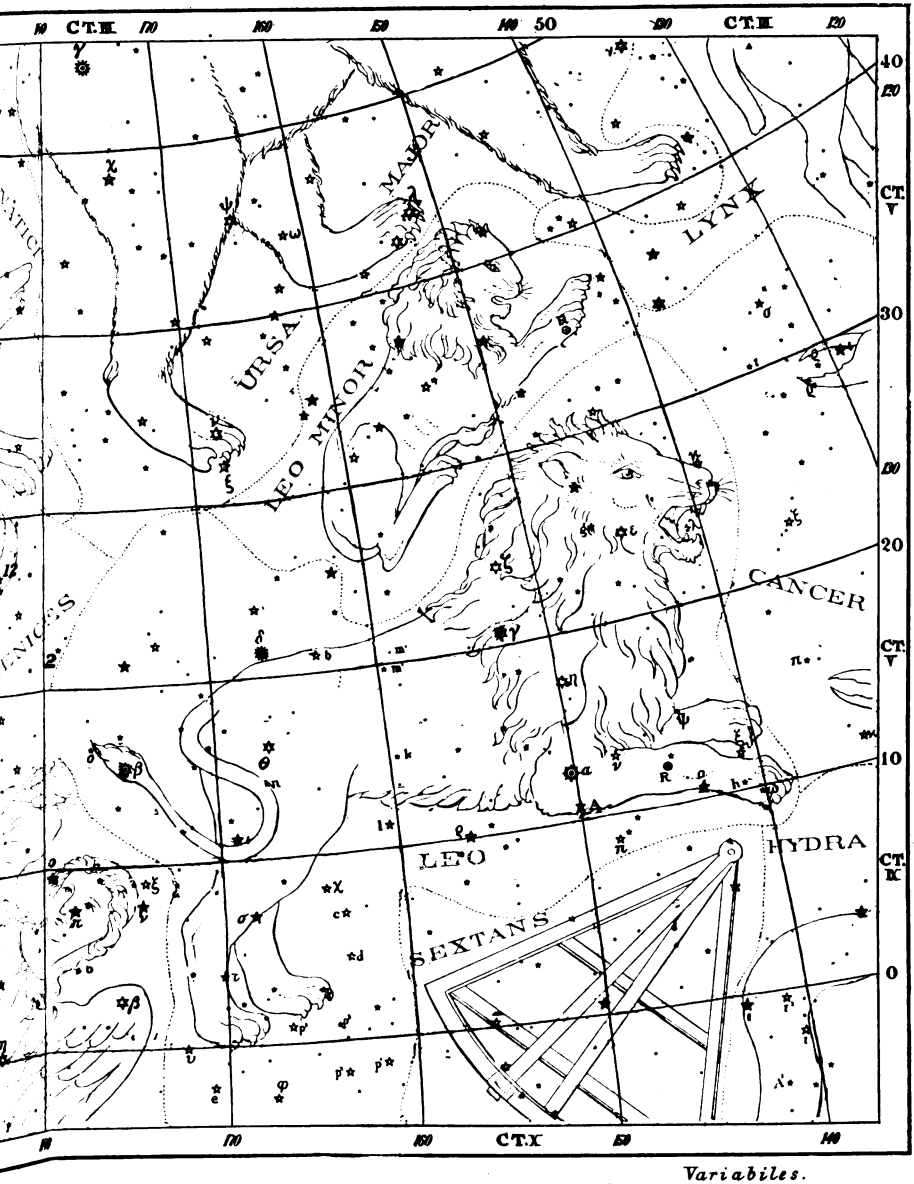
The mythology of this constellation is confusing. Although forming the claws of Scorpio in the time of Eratosthenes, it seems to have been an independent constellation at an earlier date. The Greeks at one time called it the Beam, and associated it with the scales of the Goddess of Justice. Readers of Addison will recall his beautiful dream of the Balance in the *Tatler*. In China the constellation at first represented a dragon, but afterwards a celestial balance. There are indistinct indications that in the valley of the Euphrates it stood for the Tower of Babel. It was also regarded as an altar. Another identification among the Greeks was with Pluto's chariot, in which

$\alpha = 190°$, $\delta = +20°$.



1m 2m 3m 4m 5m 6m

Chart VI



CT. III
CT. III
CT. V
CT. V
CT. IX
CT. X
URSA MAJOR
LEO MINOR
LYNX
CANCER
LEO
SEXTANS
HYDRA
Variabiles.

he ran off with Persephone, or Proserpina. For Dr. Seiss it symbolizes the Divine Judgment. He accounts for the confusion arising from its association with the claws of Scorpio by saying that in some of the ancient zodiacs the under bowl of the balance was represented as being seized by the Scorpion.

The star Delta (δ) is a remarkable short-period variable, changing every two days, seven hours and fifty-one minutes from the fifth down to less than the sixth magnitude, and back again. Variables of this kind belong to what is called the Algol type, from the star Algol in Perseus, the first of them to be discovered. Their changes are probably caused by the periodic interposition of huge dark bodies revolving around them.

Boötes

(CHARTS III, VI, AND VII)

Another breath from Homer comes to us when we reach Boötes, the great constellation of the North. The name is taken letter for letter from the Odyssey:

> So he sat and cunningly guided the craft with the helm, nor did sleep fall upon his eyelids as he viewed the Pleiades and Boötes, that setteth late, and the Bear, which they likewise call the Wain, which turneth ever in one place and alone hath no part in the baths of Ocean. This star, Calypso, the fair goddess, bade him keep ever on the left as he traversed the deep.
>
> —*Odyssey, Book V.*

The constellation is represented by the figure of a tall man, with uplifted hand, holding a leash to which

are attached the Hunting Dogs, Canes Venatici. They seem to be chasing the Greater Bear around the pole, hence the name, often given to Boötes, of the Bear Driver. But he has also been represented as a Herdsman and a Ploughman. The constellation is nearly fifty degrees in length from north to south, and immediately attracts the eye by the splendor of its principal star, the celebrated Arcturus, which many regard as the brightest star north of the celestial equator. It has, however, two rivals for this honor, Capella and Vega, or Alpha Lyræ. Photometric measurements show all three of about the same brightness—only three-tenths of a magnitude below the zero rank. But Arcturus possesses a peculiar prestige on account of the admiring mention of its name in the Book of Job, where the Almighty, answering Job out of the whirlwind, is represented as demanding, at the end of a dazzling string of astronomical allusions, "Canst thou guide Arcturus with his sons?" It is doubtful, however, whether the Hebrew poet was thinking of the star Arcturus or of the constellation Ursa Major when he wrote this magnificent passage, whose rhetoric loses none of its sublimity in the English rendering.

Arcturus is generally regarded as a red star. When near the horizon it flames splendidly, but high in the heavens its color seems to fade. There is evidence that it undergoes changes of color, and that formerly the ruddy tint was more pronounced. At present it may, perhaps, best be described as golden yellow. It is a sun of great magnitude, exceeding ours in intrinsic brilliancy at least a hundred times. Its spectrum resembles that of the sun, but indicates a

more advanced stage. In 1858, when Donati's comet blazed in the Northern sky, Arcturus shone brilliantly one night through the comet, close to the head. Curiously enough, the great comet of 1618 also passed over Arcturus without dimming its light. Arcturus is one of the "runaway suns," its proper motion amounting to two hundred or three hundred miles per second. It is moving in a southwesterly direction across the sky, the change of position amounting to more than 2″ of arc per year. It has travelled twice the diameter of the moon since the time of Ptolemy. The sudden arrest of the motion of so vast a star by means of one of the "astronomical collisions" which occasionally occur in space would produce an outburst of light exceeding anything of the kind that has ever been witnessed from the earth.

Arcturus is sometimes represented in the knee of the figure, and sometimes, like a great pendent jewel, it hangs on the hem of the giant's robe. Next to Arcturus, the brightest star in the constellation is Epsilon (ϵ), or Mirac, of the third magnitude, or, as Heis charts it, the second. This is reckoned by some observers as the most beautiful double star in the heavens, on account of the contrast of colors presented. Mirac is in the right elbow. Beta (β), or Nakkar, in the head, is of the third magnitude, as are Gamma (γ) in the left shoulder, Delta (δ) in the staff held in the right hand, Zeta (ζ) in the right foot, and Eta (η) in the left knee. A group of three fifth-magnitude stars northeast of the end of the Great Dipper's handle marks the uplifted left hand holding the leash. The most easterly of these stars, Theta (θ), bears the curi-

ous name of Alkalurops, of Arabic origin, but said by Allen to be an adaptation of the Greek name Καλαῦροψ, meaning club. The staff, or crook, in the right hand is marked by a row consisting of Psi (ψ), Delta (δ), Mu (μ), and Nu (ν), with smaller stars among them.

In all, Boötes contains one star of the first magnitude (and above), one of the second, five of the third, nine of the fourth, and twenty-four of the fifth. There are, of course, many of the sixth magnitude, but the constellation covers a space so large that as a whole it does not greatly impress the eye.

Its mythology is interesting. According to some of the Greeks, it represented Icarius, the father of Erigone. Others said that it represented Erichthonius, the inventor of chariots; still others that it was the son of Zeus and the nymph Callisto, who was changed into Ursa Major through Hera's jealousy. It was also sometimes called Arcas, the son of Zeus and Callisto. Ovid identifies Arctophilax, one of the early names of the constellation, with Arcas. Arctophilax was the Bear Watcher. According to Lockyer, the star Arcturus was one of those to which Egyptian temples were oriented. In Dr. Seiss's system of gospel mythology, Boötes represents the Great Shepherd and Harvester of Souls, and he manages to trace this prophetic meaning back through all the Oriental myths.

Mention has already been made of the beauty of the double star Mirac, or Epsilon Boötes. The magnitudes are third (or two and a half) and sixth; distance, 2″.6; colors, bright orange and brilliant emer-

ald. Delta is double; magnitudes, three and a half and eighth; distance, 110″; colors, white and pale lilac. Mu is triple; magnitudes, fourth, seventh, and eighth; distances, 108″ and 1″. Iota is double; magnitudes, fourth and seventh; distance, 38″.

Corona Borealis

(CHART VII)

When Boötes is on the meridian, the beautiful Northern Crown, Corona Borealis, is seen just to the east of it. It is one of the constellations which everybody recognizes as bearing a resemblance to the object for which it is named, for it is indeed a crown, or circlet, of stars, set with a central gem, and so manifest to the eye that nobody ever sees it for the first time without an admiring exclamation. The circle of stars is not complete, but the whole outline is at least suggested, while what may be called the front of the crown resembles a diadem in the regular arrangement of its stars. The brightest of these, "the Pearl of the Crown," is Alphacca, or Alpha (α), of between the second and third magnitude. It is sometimes called Gemma Coronæ, or simply Gemma. Five fourth-magnitude stars unite with Alphacca to form the curve of the front, or southern half, of the crown. There is one other fourth-magnitude star at some distance towards the north, and scattered over the constellation there are six stars of the fifth magnitude. In 1866 a new star, as bright as the Pearl itself, suddenly appeared near the eastern edge of the

crown. It soon faded, but is still visible with telescopes.

This constellation has been known from remote antiquity. It was called by the Greeks Ariadne's Crown, placed among the stars in memory of the unfortunate daughter of Minos, who, after giving Theseus the clew to the Cretan labyrinth, as well as her heart, was deserted by the faithless hero. Apollonius of Rhodes, in his *Tale of the Argonauts*, represents the heroes who sailed with Jason in search of the Golden Fleece as watching this constellation while they crossed the Pontus Euxinus:

> . . . the immortals divine
> Loved well that maid. In the midst of the firmament is set her sign,
> A crown of stars, which they name Ariadne's diadem,
> All night circling amidst of the signs that the heavens begem.
> —*Way's Translation.*

Plutarch has a story that, after the desertion of Theseus, Ariadne espoused Bacchus, who gave her a crown of seven stars, which, upon her death, was translated to the sky.

> And there that crown by sheeny Dionysus fixed,
> Monument of dead Ariadne.
> —*Aratus.*

The star Gamma (γ) is a famous binary; magnitudes, fourth and seventh; distance (1907), $0''.63$. Zeta is double; magnitudes, fourth and fifth; distance, $6''.3$; colors, white and blue-green.

Ursa Minor

(CHART I)

Ursa Minor, the Lesser Bear, is the polar constellation *par excellence*, and is seen on the meridian above the pole in the evenings of June. Since its most conspicuous star marks very nearly the exact north pole of the heavens, it has been an object of observation, and more or less of veneration, in all the northern hemisphere. As the figure of the imaginary bear is always drawn, the North Star, Polaris, represents the end of its long tail, by which it swings about the axis of the sky. The stars in this figure form the outline of a dipper with its handle bent the wrong way, and this is often called the Little Dipper. Its bowl hangs down towards the handle of the Great Dipper in Ursa Major. The constellation contains two stars of the second magnitude, one of the third, three of the fourth, and four of the fifth. The pole-star is the Alpha (α) of the constellation, but it is rivalled in brightness by Beta (β), or Kochab, in the bowl of the Dipper and in the flank of the imaginary bear. Alpha was called in Greece Phœnice, because the Phœnicians used this star to guide them in navigation. Its virtually fixed position in space (it is now less than one degree and a quarter from the true pole) makes it a universal sign-post for wanderers both by land and sea.

On thy unaltering blaze
The half-wrecked mariner, his compass lost,

Fixes his steady gaze,
And steers, undoubting, to the friendly coast;
And they who stray in perilous wastes by night
Are glad when thou dost shine to guide their footsteps right.
—*W. C. Bryant.*

In the days of American slavery Polaris was the star of stars for escaping slaves who sought to find their way at night towards freedom and the North. Although, in consequence of the Precession of the Equinoxes, Polaris was more than twelve degrees from the true pole in the days of Hipparchus, even then it served to indicate the north point. It is still approaching the pole, and will be within half a degree of it less than two centuries hence. After that it will recede, and in the course of some eleven thousand years will be fifty degrees distant from the pole. While the Phœnicians used Polaris, or perhaps the whole constellation, for their guide at sea, the Greek sailors seem to have employed Ursa Major for a similar purpose. Thus Aratus says:

The name of one is Cynosura,
Of the other Helice. By Helice Greek
Seafarers learn what way to steer their ships,
The other guides Phœnicians o'er the main.

Helice, it will be remembered, was the Greater Bear; Cynosura was the Lesser Bear.

The star Kochab, or Beta, in the bowl of the Little Dipper, is the rival of Polaris in brilliancy, but it differs strikingly in color. Polaris is white, or yellowish white, and Kochab is reddish. The nearest neighbor to Kochab, Gamma, is of the third magnitude. The

stars forming the back part of the bowl and the handle are of the fourth magnitude.

In Greek mythology Ursa Major and Ursa Minor were sometimes regarded as the two bears fabled to have nursed Zeus on Mount Ida. Zeus changed his nurses into nymphs, and then, instead of marrying them, translated them to the stars.

> . . . If tales are true,
> Crete was their home ere, by great Zeus's will
> They climbed the sky, because the baby Zeus
> On Ida's mount, by aromatic Dictus,
> In secret cavern they nurtured for a year.
>
> —*Aratus.*

In Babylonia it was called the Leopard, and in Egypt the Jackal of Set, or Sati. In Scandinavian mythology it was the Throne of Thor. The Finns alone among Northern nations, Mr. Allen remarks, called it the Little Bear. In China Polaris has been from ancient times an object of worship. The Rev. Joseph Edkins, in his *Religion in China*, quoted by Dr. Warren in his *Paradise Found* (an attempt to prove that the cradle of the human race was at the north pole), says:

> I met, on one occasion, a school-teacher from the neighborhood of Chafoo. He asked if I had any books to give away on astronomy and geography. . . . The inquiry was put to him: "Who is the Lord of heaven and earth?" He replied that he knew none but the Pole-star, called in the Chinese language *Teen-hwang-ta-te*, the Great Imperial Ruler of Heaven.

The North American Indians are said to have fig-

ured this constellation as a bear, but Dr. Seiss will have no bear there. For him Ursa Minor is, and always has been, a sheepfold, and he tries to show that such was the meaning of the ancient names given to it.

Among the telescopic objects of Ursa Minor, Polaris takes the first place. In the days of small telescopes it was the universal test for the optical qualities of a glass. One that would show the companion of the pole-star could be accepted without question. The component stars are of magnitudes second and ninth; distance, 18″.5; colors, yellowish white and dull blue. The large star is a spectroscopic binary.

Draco

(CHART I)

Between the two Bears curls Draco, the great Dragon of the North. It winds around three sides of the pole, and consequently occupies several months in crossing the meridian, for any fixed hour of the night, but it may best be described in this chapter.

The head of the imaginary dragon is at this time some 35° east of the pole, while the end of its tail is about 10° southwest of it. Its leading star, Alpha (*α*), or Thuban, is nearly on the meridian between the bowl of the Little Dipper and the handle of the Great Dipper. About 4650 years ago Thuban was the north polar star, and much closer to the true pole than Polaris is at the present time. Then the Dragon whirled about the pole as if balanced at the centre of its body. This star is now below the third magni-

tude, but it is believed once to have been as bright as Polaris. It possesses great interest because the mysterious central passage in the great pyramid of Chéops, which is 380 feet long and 4 feet by 3½ feet in diameter, points to the place that it occupied in the sky when it was the pole-star. It is thought that the star could then be seen by day as well as by night from the bottom of the passage, which is situated in a small chamber carved out of the solid rock deep beneath the foundation of the mighty pile.

The brightest star in Draco is now Gamma (γ), or Eltanin, in the head. Beta (β), or Rastaban, and Xi (ξ), also in the head, are of the third magnitude, and their neighbor, Nu (ν), is of the fourth. Starting with the head, whose principal stars form a striking lozenge or diamond shaped figure with the star Iota (ι) in Hercules, the eye can easily trace out the coiling figure of the Dragon, running first northeastward, then northward, then southward, then westward between the Bears, the end of the tail finally twisting towards the pole from the northwest. Over this long, winding course are distributed the third-magnitude stars Delta (δ), Zeta (ζ), Eta (η), Iota (ι), Alpha (α), Kappa (κ), and Lambda (λ).

There is, perhaps, no constellation to whose stars so many individual names have been given. The Arabs had names for all of its brighter stars, usually signifying goats or camels. Gamma is the most interesting because it was an object of temple worship in early Egypt, where it was known under the name of Isis. The temple of Hathor, at Denderah, and that of Mut, at Thebes, were so oriented that this star shone through

VIII

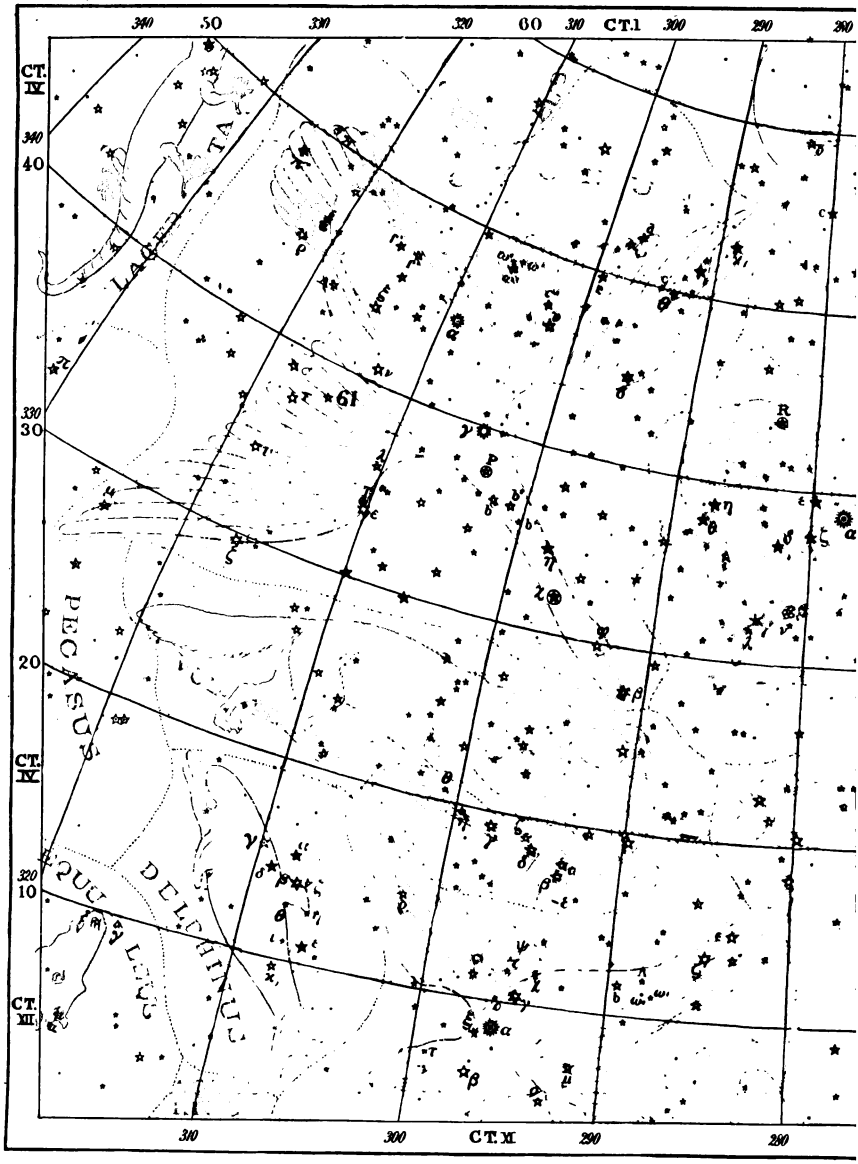
CONSTELLATIONS ON THE MERIDIAN IN JULY

Scorpio

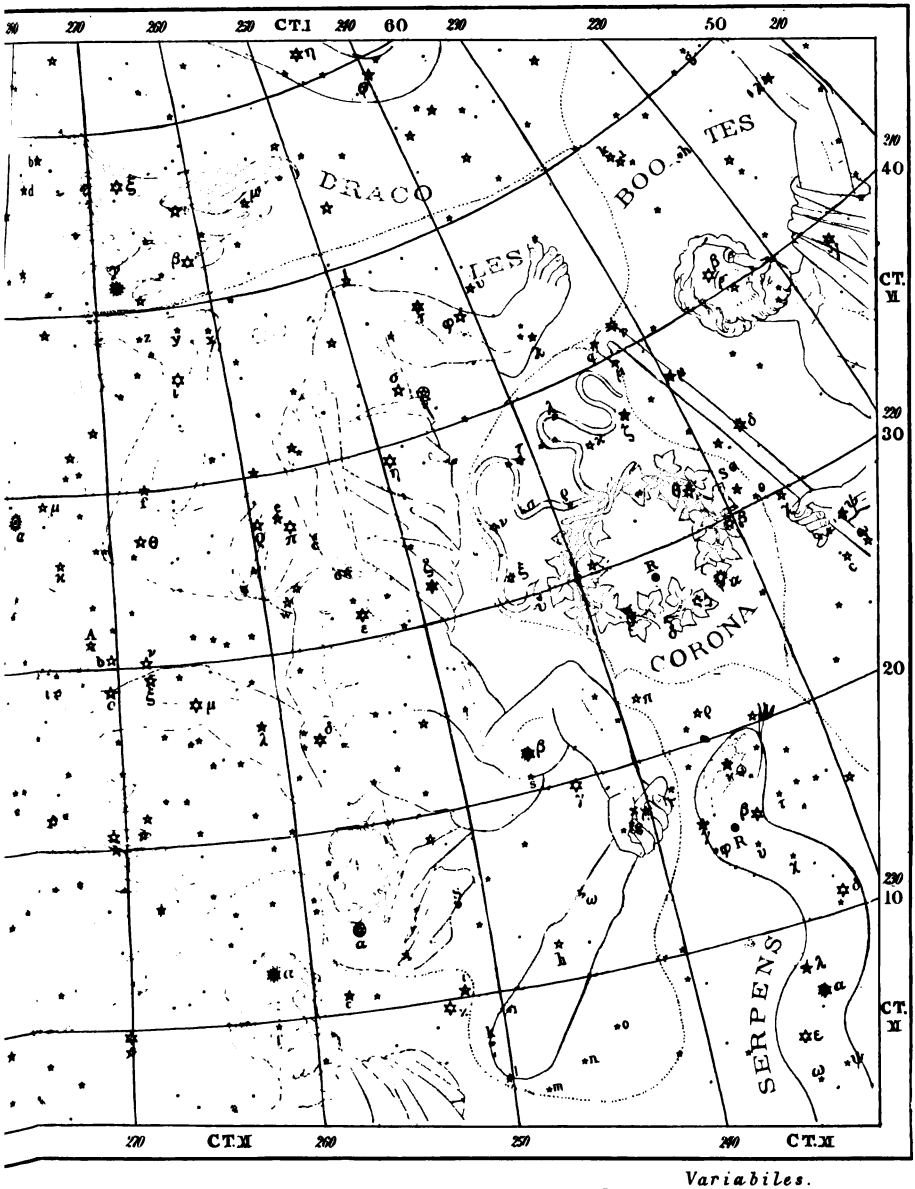
(CHART XI)

THE ninth constellation of the zodiac, and one of the most striking figures among the stars, Scorpio, the Scorpion, trails along the southern horizon on a clear summer night, stretching the stumps of its sundered claws towards Libra, very conspicuous in the absence of full moonlight on account of the splendor of its chief star, Antares, or Alpha (*α*) Scorpionis, one of the reddest stars visible to the naked eye. Its color is that of flame, and it differs in tint from both Betelgeuse and Aldebaran. The flame-like character of the light of Antares was recognized by the Chinese, who called it the Great Fire. The name Antares has been derived from the Greek *ἀντι-Ἄρης*, denoting some association, or contrast, with Ares, or Mars, the name borne from antiquity by the ruddy planet that circles between the earth and Jupiter. It is one of the four "Royal Stars," which have already been mentioned. It is generally represented as shining in the heart of the Scorpion, or where the heart may be supposed to lie, and its Arabian name was the Scorpion's Heart.

$\alpha = 275°$, $\delta = +35°$.



1ère 2ème 3ème 4ème 5ème 6ème



Variabiles.

1m 2m 3m 4m 5m 6m

Antares is rendered, if possible, more conspicuous by two small stars standing like guardians, one on either side of it. These stars, Sigma (σ) and Tau (τ), are of about the third magnitude. Two second-magnitude stars northwest of Antares, Beta (β), or Graffias, and Delta (δ), or Al Jabhab, with a third-magnitude one, Pi (π), below them, mark the front of the Scorpion's head. The tail, beginning with Epsilon (ϵ), drops down to the horizon, then turns eastward, and finally curves upward again, terminating in a conspicuous pair of stars, Lambda (λ) and Upsilon (υ), the first of the third and the other of the fourth magnitude. All told, Scorpio has one star of the first magnitude, two of the second, seven of the third, eight of the fourth, and ten of the fifth. The eastern part of the constellation is immersed in the Milky Way, near its brightest portion, where it falls behind the southern horizon in vast flaky clouds of pale luminosity.

Scorpio, in Greek fable, was the scorpion that stung Orion's heel when he was battling with the Lernæan monster. Aratus speaks of "the fiery sting of the huge portent, Scorpio, in the south wind's bosom." It may have been the color of Antares which led the old alchemists to believe that iron could be transmuted into gold only when the sun shone in the sign of Scorpio. But the astrologers did not regard it as a fortunate sign; quite the contrary, indeed, for it was said to have been the birthplace of the baleful planet Mars, and his "house"

Bright Scorpio, armed with poisonous tail, prepares
Men's martial minds for violence and wars.

His venom heats and boils their blood to rage
And rapine spreads o'er the unlucky age.
—*Manilius.*

From the "ancient mysteries" Dr. Seiss demonstrates, to his satisfaction, that Scorpio was intended to prefigure the great conflict for the salvation of mankind, and he tries to identify it with the mysterious Chambers of the South of the Book of Job.

Scorpio offers a splendid object for the telescope in Antares, a double star of singular beauty. The magnitudes are first and seventh; distance, 3″; colors, fiery red and bright emerald. I know no more attractive object for a good telescope of four or five inches' aperture. The astronomer O. M. Mitchell once saw the little green star emerging from behind the moon, during an occultation, ahead of its great red comrade. Antares belongs to the third type of stars, in which the absorbing envelopes have become so dense that they are fast approaching extinction. Sigma is double; magnitudes, fourth and ninth; distance, 22″; colors, white and plum-blue. Beta is a very beautiful double; magnitudes, second and sixth; distance, 13″; colors, white and pale blue. The larger star is again double; distance, 1″. Xi (ξ) is triple; magnitudes, fifth, fifth, and seventh; distances (1906), 0″.28 and 7″. Nu (ν) is also triple; magnitudes, fourth, seventh, and seventh; distances, 40″ and 1″.8. Rather less than half-way on a line from Antares to Beta is a celebrated star cluster, No. 4173 (80 M.). Herschel thought it the richest mass of stars in the heavens. In 1860 a new star appeared in this cluster, but lasted for only about a month. It was bright enough nearly to extinguish the cluster by its overpowering brilliancy, although it

never became brighter than the sixth magnitude. It is a comparatively recent discovery that new and variable stars are especially abundant in dense clusters, suggesting the idea of collisions. On the eastern side of this cluster is a starless spot in the sky, which was the first "black hole" in the heavens discovered by Sir William Herschel. Such openings abound in the neighboring constellation of Sagittarius, in the richest part of the Milky Way, and have given rise to interesting speculations concerning the "outer universe," where the blackest night seems to reign.

Ophiuchus and Serpens

(CHART XI)

These two involved constellations, which are more conveniently treated as one, cover a vast space in the sky, north of Scorpio, the extreme length and breadth being each about fifty degrees. They represent a giant grasping in both hands the coils of an enormous serpent, whose upraised head is seen just under the Northern Crown. The right leg of Ophiuchus is immersed to the knee in a branch of the Milky Way, above the tail of the Scorpio, while his left foot is planted over Antares. The head of the giant is marked by a lone star of the second magnitude, Alpha (α), or Ras Alhague. The third-magnitude stars Beta (β) and Pi (π) indicate the shoulders. Eta (η), in the right knee, is of near the second magnitude, and Zeta (ζ), in the left knee, of the third. Two third-magnitude stars forming a conspicuous pair, Epsilon (ϵ) and Delta (δ), mark the left hand where it grasps

the serpent. Although Ophiuchus is not a zodiacal constellation, a part of it lies across the ecliptic between the depressed tail of Scorpio and Sagittarius, so that the sun is in this constellation in the latter part of November and the beginning of December.

The head of Serpens is well marked by a group of of five stars, one of the third, two of the fourth, and two of the fifth magnitude, which form an irregular quincunx. Below these are Delta (δ), of the third magnitude; Alpha (α), or Unukalhai, of rather less than the second magnitude; Epsilon (ϵ), of the third; and Mu (μ), of the third. The figure of the Serpent then blends with that of Ophiuchus, reappearing eastward of the giant, where it has one star of the third magnitude, Eta (η), and one of the fourth, Theta (θ), which indicates the end of the tail. Alpha is in the Serpent's neck, and is sometimes called Cor Serpentis. All told, Ophiuchus and Serpens contain three stars generally ranked as of the second magnitude, twelve of the third, twelve of the fourth, and thirty-four of the fifth. Lying in a rich region of the heavens, they possess numerous stars of the sixth magnitude.

In Greek mythology Ophiuchus was the great physician Æsculapius, to whom Socrates, about to die, requested his friends to offer a cock. The legend relates that Pluto, the god of the nether regions, became alarmed at the cures of Æsculapius, who even brought the dead to life, and persuaded Zeus to remove him from the earth to the sky, where he could do no more harm. Not only the cock but the serpent was sacred to Æsculapius—in fact, the serpent was his favorite; hence the presence of Serpens with him in the

sky. In the Middle Ages, Ophiuchus was sometimes regarded as symbolizing Moses with the Brazen Serpent. Serpens was also identified with Eve's tempter in the Garden of Eden. For Dr. Seiss, Ophiuchus represents the Great Physician who was to heal the woes of mankind.

Ophiuchus and Serpens contain many interesting telescopic objects. The star 36 Ophiuchi is double; magnitudes, fifth and eighth; distance, 4″.3; colors, yellow and red. Lambda (λ) Ophiuchi is a close double; magnitudes, fourth and sixth; distance, 1″. Tau (τ) Ophiuchi is double; magnitudes, fifth and sixth; distance, 1″.8. The star 70 Ophiuchi is a binary, with a period of 95 years. The magnitudes are fourth and sixth; distance (1907), 2″.75. This star is one of those whose parallaxes have been calculated with some degree of accuracy. Its distance appears to be about one and a quarter million times the distance of the sun. Ophiuchus contains many small globular star-clusters. The great new star of 1604 appeared in this constellation. Beta Serpentis, of the third magnitude, has a ninth-magnitude companion, distant 30″. Reversing the usual order, the colors in this case are bluish for the large star and yellowish for the small one. Theta Serpentis is double; magnitudes, fourth and four and a half; distance, 21″.

Hercules

(CHART VII)

North of Ophiuchus, with his feet towards the pole and his head towards the south, kneels Hercules, "one of the oldest sky figures," says Mr. Allen, "although not known to the first Greek astronomers under that

name." The ancients seem, indeed, to have felt that there was an unexplained mystery connected with this constellation:

> Near to the Dragon's head, in toil-spent posture,
> Revolves a phantom, whose name none can tell,
> Nor what he labors at. They call him simply
> The Man upon his Knees. His knees seem bent
> In desperate struggle, while from both his shoulders
> His hands are high uplifted and outspread
> As far as he can stretch. His right foot's sole
> Is planted on the crest of the coiled Dragon.
>
> —*Aratus.*

The constellation is not conspicuous by any especial brilliancy or striking arrangement of its stars, yet it has borne many names among many nations from the remotest antiquity. One is tempted to think that some primeval legend was attached to it, only indistinct memories of which have come down into historic time and been preserved. Some have thought that it represented the Chaldean Ishdubar, or Nimroud, who slew the dragon Tiamat. In Phœnicia it is said to have represented the god Melkarth. It was also, at different times, identified with Ixion, with Prometheus bound, and with Theseus. Finally all the world settled down to the belief that it was Hercules, or Herakles, translated to the stars. Eratosthenes seems to have been the first to fix this name upon it. Some of the inventors of Bible star myths supposed that it represented Adam. But others made the twins in Gemini Adam and Eve. Dr. Seiss says:

Here is the figure of a mighty man, down on one knee, with his heel uplifted as if wounded, having a great club in one hand and a fierce three-headed monster held fast in the other, whilst his left foot is set on the head of the great Dragon. Take this figure according to the name given it in the Egyptian hieroglyphics, and you have a picture of Him who cometh to bruise the Serpent and destroy the works of the devil. In the head of this figure is a bright star, the brightest in this constellation, which bears the name of *Ras-al-gethi*, which means the Head of Him which Bruises, whilst the name of the second star means The Branch Kneeling. The Phœnicians worshipped this man five generations before the time of the Greeks, and honored him as representing a Saviour.

The star Alpha (α) is, as Dr. Seiss says, named Ras-al-gethi. It is of the third magnitude, and makes a wide pair with Alpha Ophiuchi. Beta (β), of rather above the third magnitude, bears the name Kornephoros. The most striking figure in the constellation is a large trapezium marked out by the stars Eta (η), Zeta (ζ), Epsilon (ϵ), and Pi (π).

The constellation Hercules indicates the general direction towards which the solar system is flying through space at a speed of about twelve miles per second. This motion, as far as has been ascertained, is in a straight line, no proof of curvature having been discovered. But Hercules is so distant that the solar system, if its great journey should be unswervingly pursued, would require more than 125,000 years to arrive in the neighborhood of the nearest star of the constellation.

Nearly on a line between Eta and Zeta Hercules, and about one-third of the distance from the former

to the latter, a faint speck, barely visible to a good eye, but easily noticeable with a strong opera-glass or field-glass, indicates the location of one of the supreme wonders of the universe—the Great Star Cluster in Hercules (No. 4230, or M 13). Its glory, of course, is only to be seen and appreciated with the aid of a powerful telescope, but a knowledge of its situation in space cannot but interest everybody. I recall a night spent with Prof. E. E. Barnard under the dome of the great Lick telescope, when we looked into the heart of this amazing telescopic globule of stellar atoms, and seemed to see it resolved into separate but innumerable stars to its very centre.

There is no way to describe such a spectacle! It arouses and at the same time daunts the imagination. One can find no words for it. More than twice as many stars as the sharpest eye can see in the whole heavens — northern and southern hemispheres both included—are there packed into a space so small to our eyes that it would not make a visible speck on the face of the moon. It is, perhaps, idle to speculate on the way in which those thronging suns came to be associated in that manner. There they are—a perpetual challenge to man to declare, if he knoweth, "the ordinances of Heaven!"

Hercules is full of beautiful double stars. Kappa, of the fifth magnitude, has a seventh-magnitude companion at a distance of 31″. The colors are light yellow and pale red. In Gamma, another double, the magnitudes are third and ninth; distance, 38″. Alpha is a charming telescopic object; magnitudes, third and sixth; distance, 4″.7; colors, orange and

green. Delta combines a pale green with a purple star; magnitudes, third and eighth; distance, 19″. Zeta is a close binary; magnitudes, third and sixth or seventh; distance (1907), 1″.23. The period of revolution of these stars is 35 years. Rho (ρ) is a beautiful double; magnitudes, fourth and sixth; distance, 3″.7; colors, both green or blue, but differing in tone. The double 95 is perhaps the most remarkable of all in its colors. The magnitudes are fifth and five and a half; distance, 6″; colors, according to the Rev. T. W. Webb, light apple-green and cherry-red.

IX

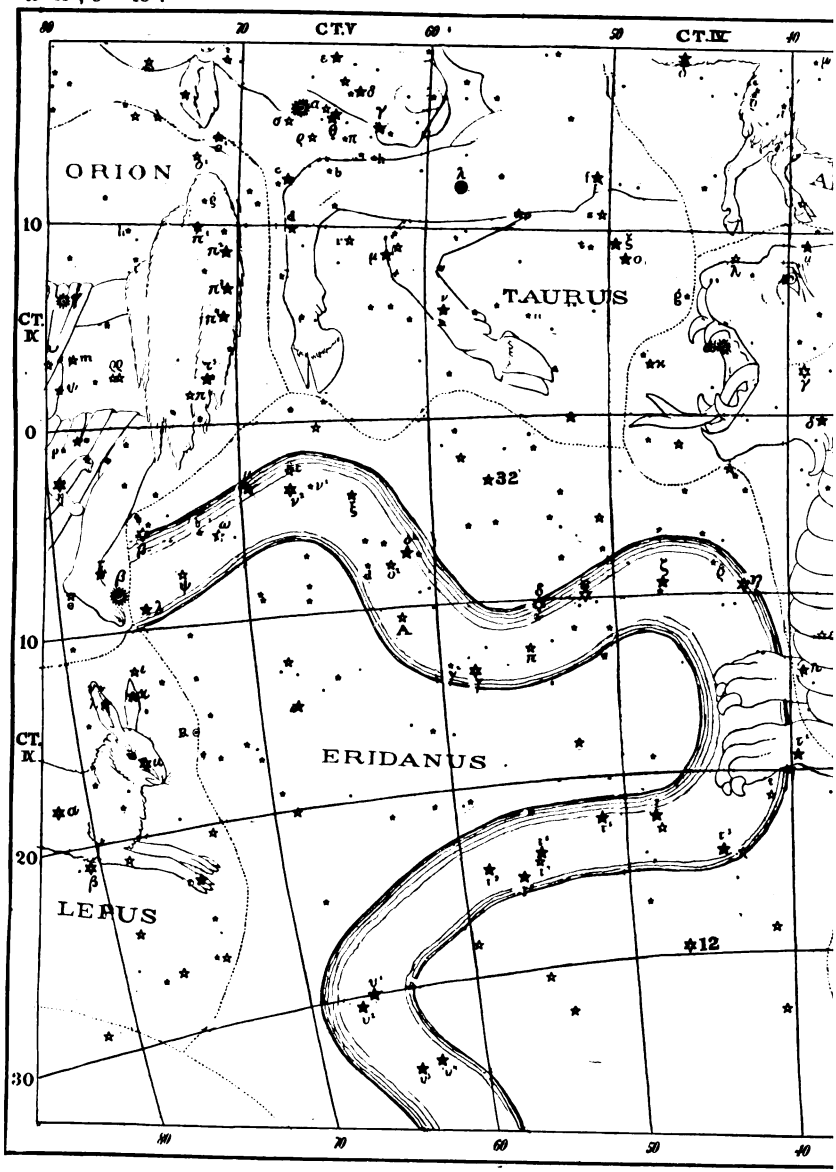
CONSTELLATIONS ON THE MERIDIAN IN AUGUST

Sagittarius

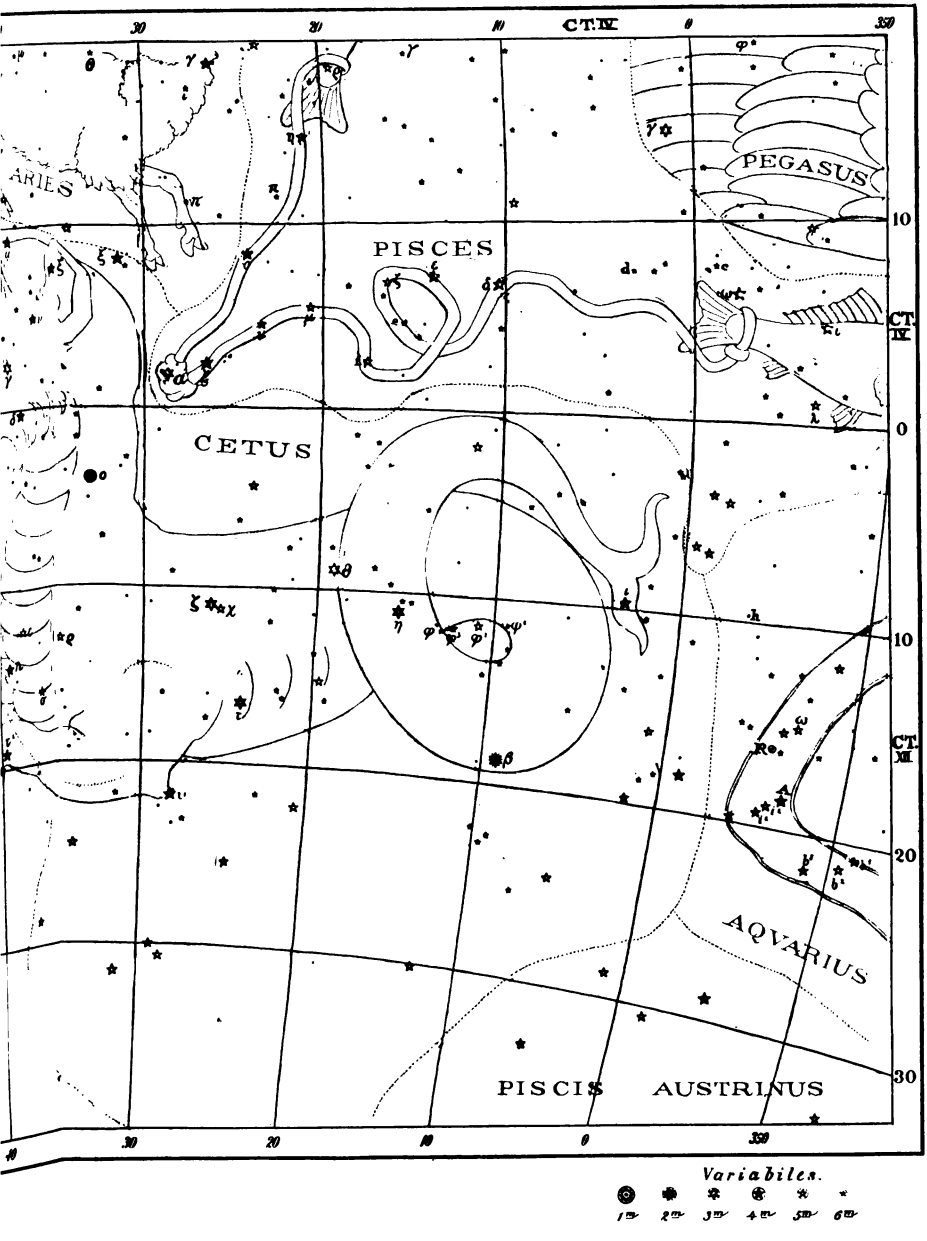
(CHART XI)

TO lie on the warm sands of a south-fronting seacoast, or on the deck of a transatlantic liner, on an August evening, and watch the Milk Dipper in Sagittarius ladling the golden flood of the Milky Way, is a summer-night's pleasure which reserves its full enjoyment for those who know the constellations. Sagittarius, the Archer, is the tenth constellation of the zodiac, and, like Scorpio, lies low on the southern horizon when seen from median northern latitudes. It has no star of the first magnitude, and only one approaching the second, but the presence of the Milky Way, branching on all sides in luminous deeps and shallows, lends a certain splendor to the constellation through which it flows. Sagittarius is full of star-clusters, two of which are visible to the naked eye—M 24 and M 25. The former, which is two or three times as broad as the full moon, resembles a projection at the edge of the Milky Way. The Milk Dipper, with its short handle, is outlined by the stars Zeta (ζ), Tau (τ), Sigma (σ), Phi (ϕ), Lambda (λ),

$\alpha = 55°$, $\delta = -10°$.



1m 2m 3m 4m 5m 6m


30
20
10
CT. IV
0
350
ARIES
PEGASUS
PISCES
CETUS
AQVARIUS
PISCIS AUSTRINUS
10
CT. IV
0
10
CT. XI
20
30
Variables.
1m 2m 3m 4m 5m 6m

and Mu (μ). Zeta, Sigma, Lambda, and Delta (δ) indicate the upturned bowl of a larger dipper, of which Gamma (γ) may be taken for the stump of a handle on the west. The figure of the Archer is not so evident. Sigma, the brightest star in the constellation, shines in the shoulder, Zeta in the upper part of the arm, while Delta and Gamma indicate an arrow about to be shot westward from a bow, the outline of which is traced by Lambda, Delta, and Epsilon (ϵ). Eta (η), below Epsilon, is in the lower half of the bow, and Mu in its upper tip. Just above this tip glows the splendid cluster M 24. The head of the Archer is marked by a group of five stars ten degrees east of M 24, of which the brightest, Pi (π), is of the third magnitude.

The Alpha (α) and Beta (β) of the constellation, not as bright as some of the stars in the Milk Dipper and Bow, lie too far south to be seen from the United States. For this reason a part of the hind-quarters and the legs of the Centaur appear to be cut off in our figure.

This Archer is fabled to have been one of the Centaurs who was killed by Herakles for attacking his bride. Herakles had poisoned his arrow with the blood of the Lernæan monster, so that the Centaur could not recover from the wound, although Zeus was his friend and Æsculapius his physician. But Zeus did not forget to translate him to the sky:

> Midst golden stars he stands resplendent now,
> And thrusts the Scorpion with his bended bow.
> —*Ovid.*

In China this constellation was figured as a tiger, but the ancients in general regarded it as representing

a bowman. With the Jews it was the bow of Ephraim and Manasseh. Dr. Seiss calls it "a pictorial prophecy of our blessed Lord." There is another Centaur in the southern hemisphere of the sky, the mythology of which has sometimes been confused with that of Sagittarius.

The telescopic riches of Sagittarius are especially remarkable, as already indicated, for the beautiful star-clusters that they include. Some of these clusters are more wonderful in photographs than they appear in the best telescopes. One of Barnard's photographs shows, in the cluster M 8 (also visible to the naked eye as a glimmering speck), a strange black hole opening out like a window into starless space beyond. The cluster appears to be made up of a curious assemblage of star-clouds and nebulæ.

Scutum Sobieskii

(CHART XI)

The little constellation called Sobieski's Shield was formed by Hevelius in honor of John Sobieski III., King of Poland. It contains one fourth and five fifth magnitude stars, which Hevelius regarded as "unclaimed" by the ancient constellation-makers. It lies between the head of Sagittarius and the tail of Serpens, and is interesting only for its star-clusters and for the brilliancy of the Milky Way within its boundaries. Sir William Herschel estimated that it contained more than 300,000 stars.

One of its star-clouds, visible to the naked eye, has been photographed by Barnard, and its richness is beyond all belief. It looks like a gathering of fiery cirrocumuli, and yet it consists of nothing but stars.

Aquila

(CHARTS XI AND XII)

Northeast of Scutum Sobieskii flies Aquila the Eagle. The lower part of this constellation is sometimes called Antinoüs, a name said to have been given to it by the Emperor Hadrian in honor of his favorite attendant, who was drowned in the Nile, and in the representation of whose youthful beauty sculptors afterwards contended so industriously that they filled the Roman world with his statues, vying in grace with some of the work of their masters, the Greeks. Aquila is plainly marked for the naked eye by its chief star, Altair, Alpha (α), and its two attendants placed one on either side like those of Antares. Altair is of near the first magnitude; one of its attendants, Gamma (γ), is of the third magnitude, and the other, Beta (β), of the fourth. Two other third-magnitude stars, Delta (δ) and Lambda (λ), lie in a line extending towards Scutum Sobieskii. Altair is in the neck of the eagle, and Zeta (ζ), of the third magnitude, in its tail. The star Theta (θ), of the third magnitude, is in one of the hands of Antinoüs. A more evident representation of a spread eagle would be made by taking Altair for the head, Zeta and Theta for the tips of the wings, and Delta for the tail. The Milky Way is brilliant in Aquila.

Aquila appearing before the sun late in the year was regarded by the ancients as a harbinger of tempests—

> . . . dangerous when he rises
> Before the dawn, the eagle of the winds men call him.
> —*Aratus.*

This constellation and Lyra, on the other side of the Milky Way, are associated with the curious Chinese legend of the Spinning Damsel and the Magpie Bridge, which is also found in Korea. The story varies, but in substance runs as follows: A cowherd fell in love with the Spinning Damsel. Her father, in anger, banished them both to the sky, where the cowherd became Aquila and the Spinning Damsel Lyra. But with that tender regard for romance which characterized the ancient powers that translated people to the stars, the angry father decreed that the lovers should meet once a year if they could contrive to cross the river—the Milky Way. This they were enabled to do with the aid of their friends, the magpies, who still once a year, on the seventh night of the seventh moon, congregate at the crossing-point and form a bridge over which the lovers pass. At the end of twenty-four hours the bridge breaks up, the magpies return to earth, and the lovers must wait another year before meeting again. In Korea, if a magpie is seen about its usual haunts at this time, the children stone it for shirking its duty when it ought to be helping to form the bridge for the lovers in the sky.

As Lafcadio Hearn found this story during his residence in Japan, it seemed to him to be the origin of the festival called Tanabata, always distinctively a woman's holiday from the earliest times. The name of the Spinning Damsel was Orihimé, another form of Tanabata, and her lover was a peasant lad who, driving an ox, one day passed her loom and instantly won her heart. In the sky the lovers are known as the

Herdsman and the Weaver, and the popular legend associated with the Tanabata festival avers that their meeting can be observed by anybody with good eyes, for whenever it occurs the lovers' stars burn with five different colors. That is why offerings of five colors are made by the celebrants, and why the poems which are composed for the occasion are written on paper of five different tints. The legend goes on to say that if rain falls on the seventh night of the seventh moon, the meeting cannot occur, because the heavenly river rises and becomes too broad to be spanned by the Magpie Bridge. For this reason rain on the Tanabata night is called the Rain of Tears.

In Greece and Rome, Aquila was the sacred bird of Jove. Dr. Seiss, connecting it with the little constellation of Sagitta the Arrow, close at hand, regards it as symbolical of the Wounded Prince, or Christ suffering for mankind.

Pi (π) Aquilæ is double; magnitudes, sixth and seventh; distance, 1″.6. Eta (η) is a remarkable variable, changing from magnitude three and a half to magnitude four and a half, and back again, every seven days, four hours, and fourteen minutes.

Sagitta

(CHART VII)

The little constellation of the Arrow lies north of Aquila, and consists of a striking row of fourth and fifth magnitude stars running east and west about ten degrees. Small as it is, Sagitta is an ancient asterism known to the Greeks. Aratus, referring to the arrow of the Archer, says:

Another arrow flies on high
Launched by no bow. Near it to the north
Flies the Bird.

This bird is not Aquila, but Cygnus, to be described later. Eratosthenes made Sagitta the arrow of Apollo, but others before him had identified it with one of the arrows of Herakles shot against the Stymphalian birds. Julius Schillerius, in the seventeenth century, in his *Cœlum Stellatum Christianum*, represented Sagitta as the Spear of the Crucifixion, which recalls Dr. Seiss's idea about Aquila mentioned above.

The star Delta (δ) is double; magnitudes, fifth and ninth; distance, $8''.6$.

Lyra

(CHART VII)

Just on the meridian northwest of Aquila shines one of the most superb of all the first-magnitude stars, Vega, or Alpha of the Lyre (Alpha Lyræ), of which Burritt justly says: "The remarkable brightness of *a* Lyræ has attracted the admiration of astronomers in all ages."

The constellation Lyra is not large, but there are few which more quickly arrest the attention.

I saw, with its celestial keys,
Its chords of air, its frets of fire,
The Samian's great Æolian lyre,
Rising thro' all its sevenfold bars
From earth unto the fixed stars.
—*Longfellow, Occultation of Orion.*

This refers to the old Greek legend associating the harp in the stars with the magic instrument with which Orpheus charmed stones and trees, and invaded the infernal regions in search of his lost Eurydice. With the Persians it was also a lyre. The ancient Britons called it King Arthur's Harp.

The principal star, Alpha (α), or Vega, derived from Wega, a malformed Arabic word, first received the name it now bears in King Alfonso's stellar tables. In magnitude it equals Arcturus and Capella, being only three-tenths of a magnitude below the zero rank. The brilliancy of its blue-white rays is astonishing, and their color is beautifully revealed in a telescope. Perhaps it approaches nearer to the idea of "a diamond in the sky" than any other star. Its actual magnitude is very great, probably a hundred times that of the sun. It belongs to the Sirian type, being young in the order of evolution. Two little stars of between the fourth and fifth magnitudes, Epsilon (ϵ) and Zeta (ζ), form a beautiful little triangle with Vega, by means of which the beginner may always recognize the latter. Beta (β) and Gamma (γ), about eight degrees below Vega, are of the third magnitude, and mark the top of the strings of the imaginary harp, whose base is towards the north.

About fourteen thousand years ago Vega was the north polar-star, and, in consequence of the precession of the equinoxes, it will occupy the same position about eleven thousand years hence. It is now more than fifty degrees from the pole. According to some recent estimates, the apex of the Solar Way—that is, the direction of the motion of the solar system—is

towards Lyra. In that case, half a million years from now the earth may find itself in the presence of a mighty blue-white sun, a hundredfold more brilliant than its present orb of day. The parallax of Vega is about 0″.1, and the amount of light that it sends us from its present distance is about one forty-thousand-millionth of that received from the sun.

Lyra contains one star of the first magnitude, one of the third, five of the fourth, and eight of the fifth.

The ancient mythology of Lyra has already been indicated. In Dr. Seiss's system it symbolized the rejoicing in heaven at the final victory over the powers of evil, and, after his way, he traces this meaning through all the antique legends concerning the Harp.

Vega has a tenth-magnitude companion, distance, 48″, which is a well-known test for telescopes of moderate power. Epsilon is a celebrated quadruple star. An opera-glass, and some eyes without optical aid, separate it into two nearly equal stars almost touching each other. A small telescope divides each of these into two, between 2″ and 3″ apart. A more powerful glass shows two faint stars between the pairs. These faint stars were called by Sir John Herschel the *debillissima*. Zeta is also double; magnitudes, fourth and sixth; distance, 44″. Beta is variable, losing and regaining one entire magnitude in a period of twelve days, twenty-one hours, and forty-seven minutes. On a line between Beta and Gamma, and about one-third of the distance from the first to the second, is found the celebrated Ring Nebula, which a three-inch telescope will show as a faint, minute circle, like a little smoke ring. This ring has about one-thirtieth the apparent diameter of the

full moon to the naked eye. Recent photographs of this object reveal it as a most wonderful ring of inter-twisted spirals. In the centre is a small star of surprising actinic power, since it appears a hundred times more conspicuous in a photograph than in a telescope.

X

CONSTELLATIONS ON THE MERIDIAN IN SEPTEMBER

Capricornus

(CHART XII)

CAPRICORN, the Goat, is the eleventh constellation of the zodiac. Its two leading stars, Alpha (α), or Algiedi, and Beta (β), or Dabih, are seen just west of the meridian at nine o'clock on the 15th of September. Before the precession of the equinoxes had carried the *signs* of the zodiac westward out of the constellations with which they were formerly identified (the motion amounts to a little more than 50″ per year), the sun was in Capricornus at the time of the winter solstice. This is the origin of Aratus's lines in the *Phainomena:*

> . . . Capricorn, the goal that turns the sun.
> Be it ne'er thy lot in that month to be tossed
> On the mid-ocean; neither by day
> Far sailest thou, for few the hours of light,
> Nor early on thy peril breaks the dawn,
> For all thy invocations. Pitiless
> Siroccos lash the main when Capricorn
> Lodges the sun, and Zeus sends bitter cold
> To numb the frozen sailors.
>
> —*Poste's translation.*

$\alpha = 105°$; $\delta = -8°$.

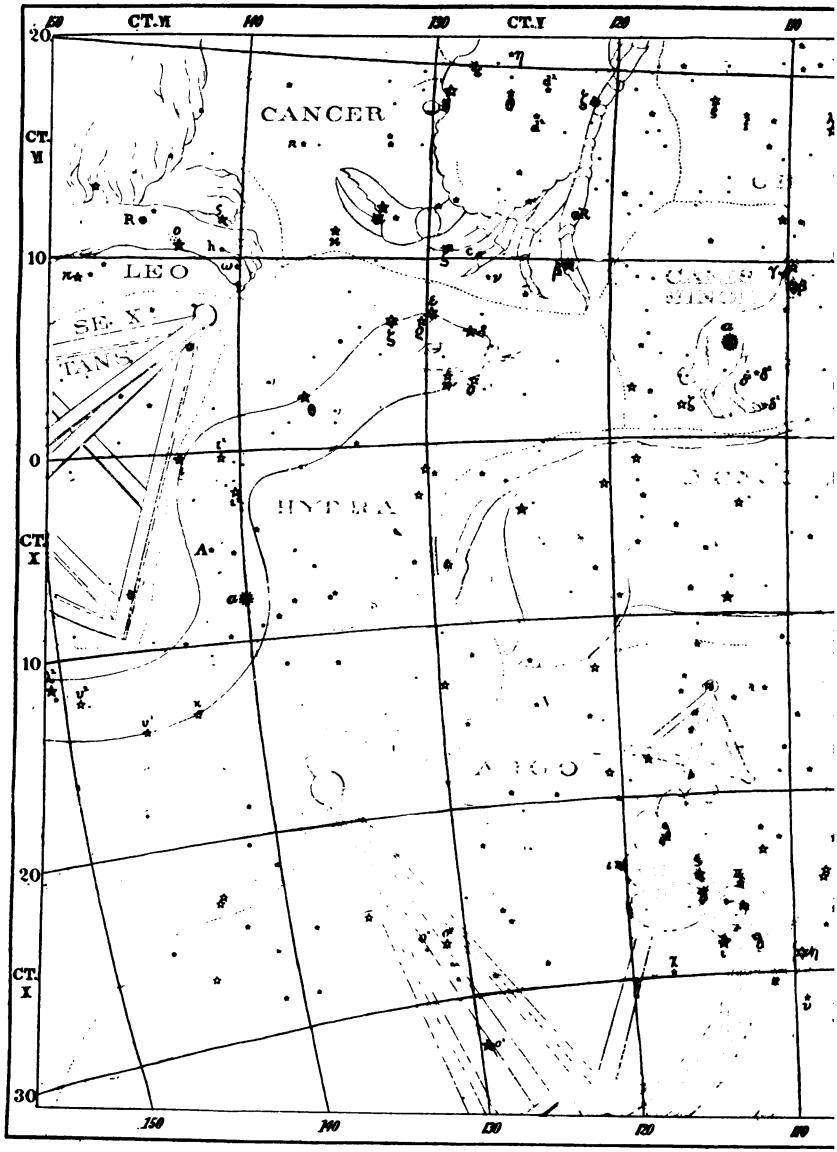
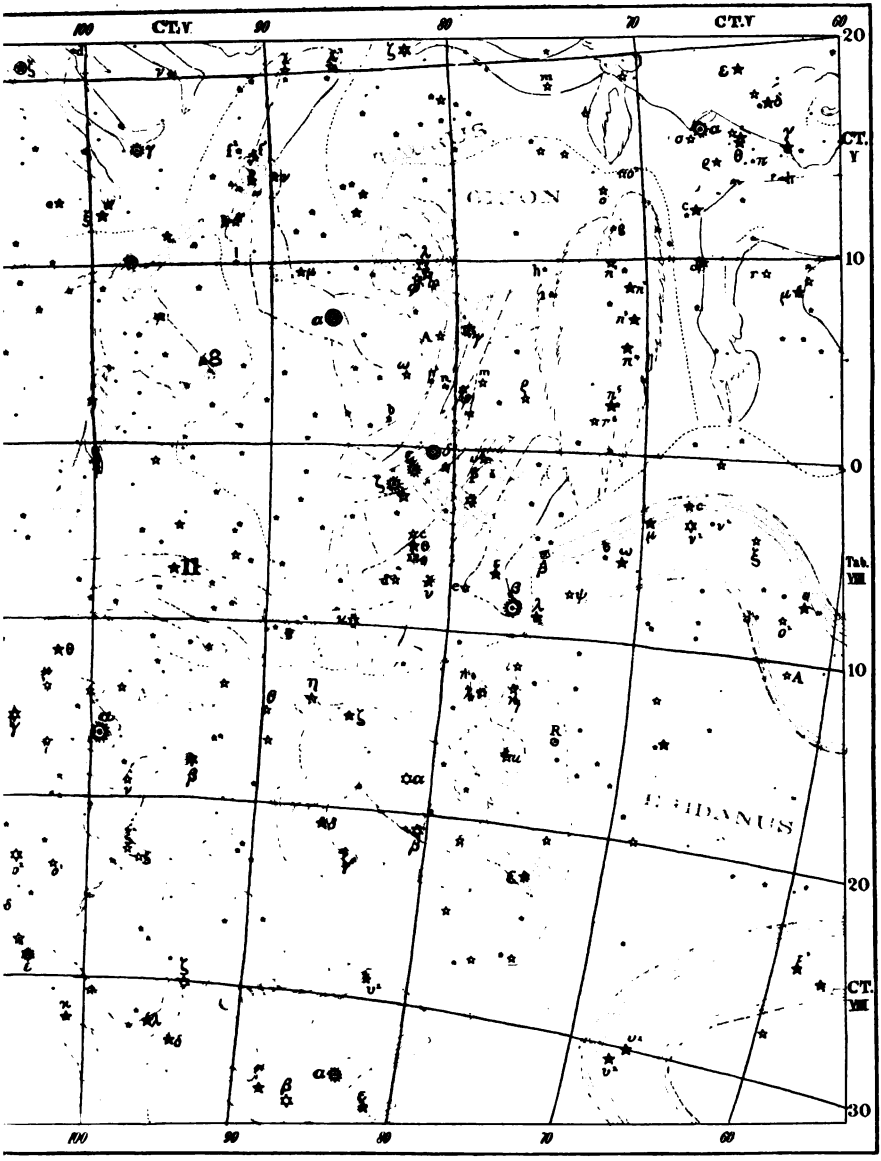


Chart IX



CONSTELLATIONS IN SEPTEMBER

At present the sun does not touch the constellation Capricornus until the middle of January, but the description of the kind of weather prevailing at sea when the sun is in Capricornus will still hold good, as transatlantic travellers know to their cost. Zeus has not forgotten how to plague the sailors, and Neptune is unabashed by turbines.

Capricornus is not very well marked out as a figure among the stars. Alpha and Beta, of the third magnitude, are in the head of the goat, and Delta (δ), of the same magnitude, is in the hind-quarters. There are, besides, seven fourth and ten fifth magnitude stars scattered over the constellation.

In Grecian mythology Capricornus occupied a conspicuous place as the Gate of the Gods, it being fabled that the souls of men passed through its stars on their way to a better scene. Berosus, who, it will be remembered, predicted the destruction of the earth by water, when all the planets should assemble in Cancer, declared that the globe would be burned with fire when a similar conjunction should take place in Capricorn. So Berosus, after the manner of his astrological brethren, even to the present day, took good pains to provide for contrary events in his prognostications. He would not let mankind escape either way.

According to another legend, Capricornus represents Pan, who one day, in a frolicsome mood, and he was seldom long in any other, jumped into the Nile and transformed himself, for the amusement of the onlooking gods, into a kind of amphibious monster, the part of his body under the water assuming a fish-shape, while that above water looked like a goat.

Zeus was so delighted that he decreed that this form should be translated to the stars, whence the ancient representation of Capricornus as a cross between a goat and a fish. But Dr. Seiss brings us back to a serious view by averring that the Goat-Fish shines among the stars as a symbol of sacrifice and atonement.

Both Alpha and Beta are naked-eye doubles—at least, Alpha is easily seen double, its two stars being 6′ apart, while an exceptional eye may catch a glimpse of the sixth-magnitude star within $3\frac{1}{2}'$ of Beta. Each of the stars in Alpha is telescopically double. In a^1 the magnitudes are fourth and eighth (distance 44″), and in a^2 third and tenth or eleventh (distance, 7″.4). A little group of fifth and sixth magnitude stars below Beta, in the mouth of the Goat, forms a pretty sight. One of these, Rho (ρ), is an attractive double; magnitudes, fifth and eighth; distance, 3″.8. Three of the other stars in this group are also doubles.

Delphinus

(CHART XII)

A part of the next zodiacal constellation, Aquarius, lies north of the eastern half of Capricornus, but we shall come to this later. At present we lift our eyes higher towards the north, where, just east of Sagitta, we see the remarkable little constellation Delphinus (the Dolphin), popularly known as Job's Coffin. Two stars of the third, two of the fourth, and one of the fifth magnitude crowded closely together mark out an irregular oblong figure, which is prolonged towards the south by another star of the fourth, one of the fifth, and three of the sixth magnitude. The curved

outline of a dolphin, with its head uppermost, is not difficult to trace.

> The tiny Dolphin floats o'er Capricorn,
> His middle dusky, but he has four eyes,
> Two parallel to two.
>
> —*Aratus.*

Greek fable asserted that this constellation represented the dolphin that bore Arion safe to land after the sailors had thrown him overboard in the Gulf of Corinth. The scene of this adventure was certainly well chosen, for the Gulf of Corinth seems to swarm with dolphins. I remember one sunshiny morning entering the port of Itea on the way to Delphi, when our little steamer seemed to be escorted by dolphins, whose graceful bodies, visible in the translucent sea at a great depth, rose in an endless procession to throw glittering curves on the surface of the water at either side of the ship.

Another ancient myth associates Delphinus with Amphitrite, the nereid whom a dolphin carried to Neptune to become his bride.

The star Gamma (γ) is a very charming double; magnitudes, fourth and fifth; distance, 11″; colors, gold and emerald. Both Alpha and Beta have faint companions, and the larger star in Beta is a binary whose components are only separable with very powerful telescopes.

Equuleus

(CHART XII)

The little constellation of Equuleus, the Foal, southeast of Delphinus, is interesting to possessors of good

telescopes on account of its many close double and triple stars; but to the naked eye it offers no attraction, having but one star as bright as the fourth magnitude. It is, however, an ancient constellation, and, lying close by the head of Pegasus, was mythologically associated with the winged horse, some asserting that it represented the brother of Pegasus, ridden by Castor, and others that it was the horse that sprang forth from the rock which Neptune struck with his trident when he and Athene were trying to outdo each other in Olympian magic.

Vulpecula

(CHART VII)

North of Delphinus and Sagitta lies another small constellation, Vulpecula, the Little Fox. It is one of Hevelius's constellations, and is too inconspicuous to deserve notice if it were not included in all celestial charts and star catalogues. Although it is 35° long from east to west, and about 10° broad, it has only one star approaching the fourth magnitude in brightness. Telescopically it is interesting for containing the celebrated Dumb-bell nebula first seen by Lord Rosse with his gigantic six-foot reflector, but much more fully revealed in modern photographs. Its photographic appearance is rather that of an hour-glass, and it looks as though two enormous masses were gradually separating, very much as the moon and the earth are supposed to have separated when their originally combined mass was in a plastic state.

Cygnus

(CHART VII)

Again we come to one of the great figures in the stars which everybody can recognize at a glance—the Northern Cross in the constellation Cygnus, the Swan. The form of the cross is evident; that of the swan may be recognized as soon as the fact is pointed out that the long beam of the cross indicates the out-stretched neck of the bird, flying southwestward, while the branches of the cross-arm represent the out-stretched wings.

Before the time of Eratosthenes (third century B.C.) the name of this constellation among the Greeks was simply the Bird. Thus Aratus wrote:

> For heaven's floor has a fleet-winged Bird;
> Airy his body, his wings roughened
> With stars, not largest sized and yet not dim,
> Exulting in the blue deeps of the sky,
> Down the gale westward floating, his right pennons graze
> The right hand of Cepheus,
> His left the feet of prancing Pegasus.
>
> —*Poste's translation.*

It was also called the Hen, and in some old celestial charts is represented by the figure of a motherly barnyard fowl.

Its leading star, Alpha (α), or Deneb, is sometimes ranked of the first magnitude, although its actual brightness is considerably less than the standard. It is a sun of the Sirian type and of great magnitude. The star Beta (β), or Albireo, in the foot of the cross,

or the beak of the swan, is one of the most beautiful doubles known. It is a very easy object to view, even a strong binocular or field-glass serving to reveal the fact that the star is duplicate. The smallest telescope at once splits it up into a third and a seventh magnitude star, 34″ apart, the former light yellow, the latter deep blue. The color of the blue star is so pronounced and the contrast is so beautiful that the effect produced upon the eye recalls that of a pair of skilfully combined gems. Albireo is a favorite show object for all possessors of small telescopes who invite their friends to look at the beauties of the heavens. It resembles "a picture with a story" in a connoisseur's collection—everybody can appreciate it.

Another very famous object in Cygnus is the little star 61, long known as the nearest star in the northern hemisphere. Its parallax is about 0″.4, and, unlike the other stars that we have compared in actual brilliancy with the sun, it is relatively insignificant. It would take ten stars like 61 Cygni to equal the sun. The components are both of the sixth magnitude, and their distance apart is about 20″, so that the smallest telescope suffices to separate them.

The Milky Way passing through Cygnus adds to the beauty of the constellation, and there are many splendid fields for the opera-glass. In the space between Alpha, Gamma, and Epsilon there is a great void in the Milky Way known as the Northern Coal Sack, whose darkness is all the more striking on account of the fact that between Alpha and Gamma lie streams of minute stars of astonishing richness and beauty. Cygnus is also full of nebulous clouds, some

of which, when photographed, exhibit the most extraordinary forms and texture. Among them is one appropriately called the Lace Nebula. Its delicate streamers look like a tangle of gossamer threads blown by the wind, with thousands of stars sprinkled about them. A new star appeared in Cygnus in 1876, afterwards apparently changing into a nebula.

Cygnus has, in all, one star of the second magnitude approaching the first, five of the third, fifteen of the fourth, and thirty-four of the fifth. Owing to its position in the Milky Way, its sixth-magnitude stars are very numerous, while for stars of telescopic magnitudes there is no richer region in the heavens.

Among the telescopic objects of this constellation besides Albireo and 61 Cygni, already described, may be mentioned Delta (δ), a double of magnitudes third and eighth; distance, $1''.6$. Psi (ψ) consists of a white star of magnitude five and a half, combined with a lilac star of magnitude seven and a half, the distance being $3''$. Mu (μ), of magnitude five, has a blue companion of magnitude six, at a distance of $2''.4$.

XI

CONSTELLATIONS ON THE MERIDIAN IN OCTOBER

Aquarius

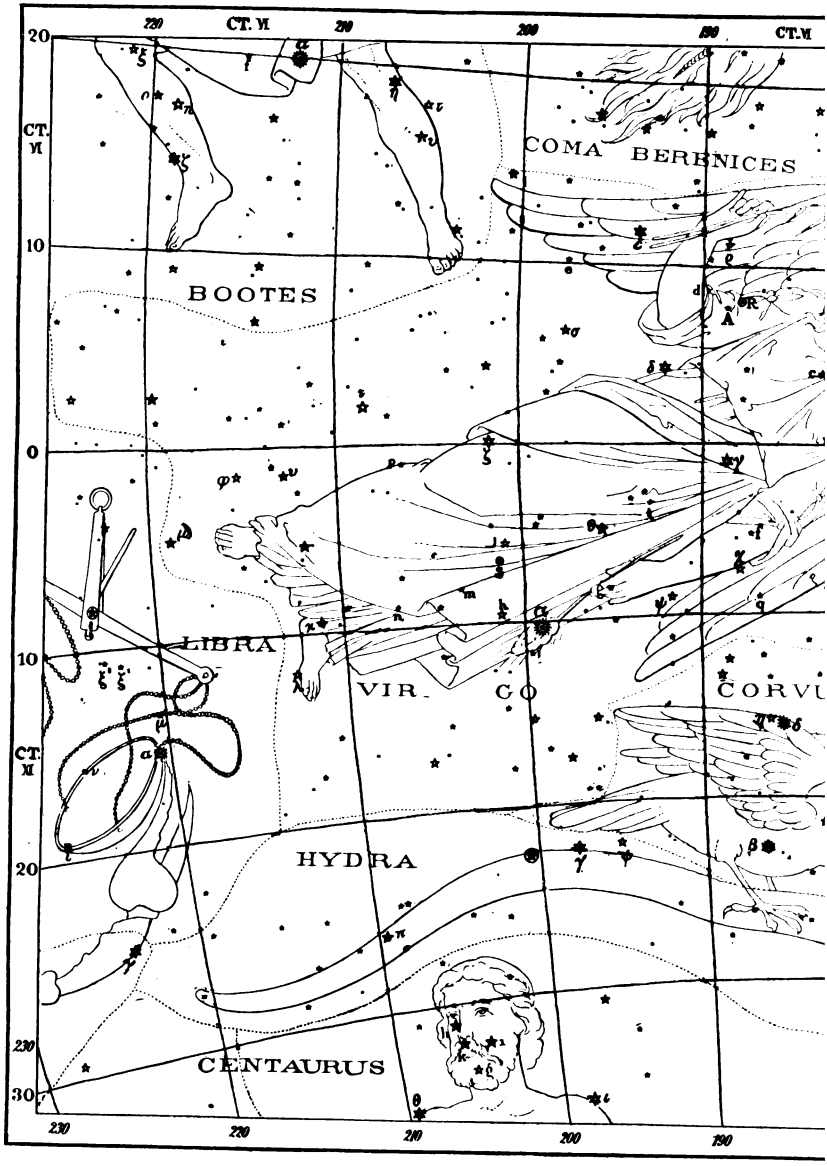
(CHART XII)

FOR some reason all of the ancients imagined that the part of the sky occupied by Aquarius, the Waterman or Water-bearer, and its neighboring constellations contained a celestial sea. Ideler has undertaken to find a reason for this in the fact that the sun passes through that part of the heavens during the rainy season of the year. The constellation Aquarius has been represented by virtually the same figure from the days of ancient Babylon. A man is seen pouring water from an urn. An Egyptian legend averred that the floods of the Nile were caused by the Water-bearer sinking his huge urn into the fountains of the river to refill it.

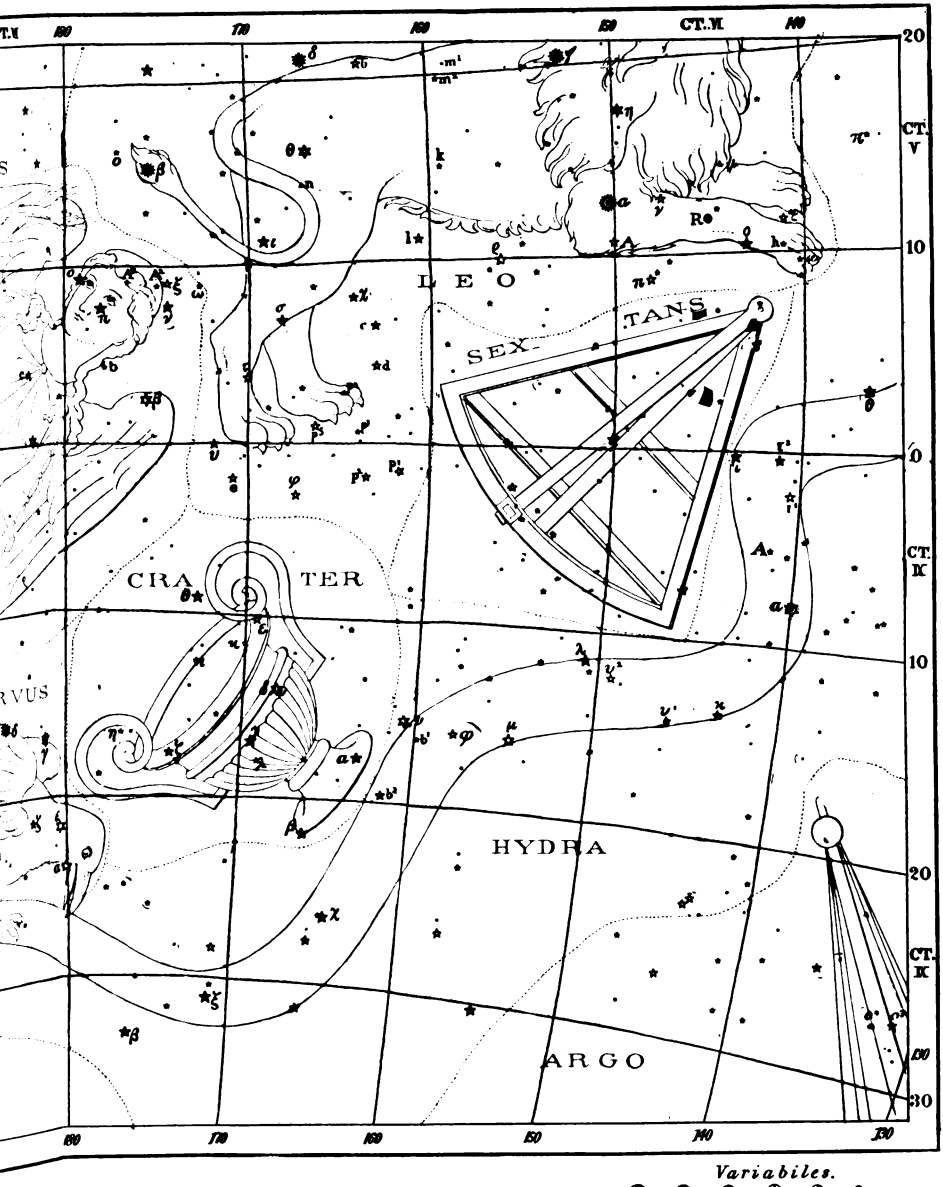
Aquarius is the twelfth constellation of the zodiac, lying immediately east of Capricornus, but curving round on the north of the latter to the border of Aquila.

The constellation is not remarkable to the eye, as it contains no stars brighter than the third magnitude. There are four or five of about that rank: Alpha (*α*),

$\alpha - 180°$, $\delta - -8°$.



1m 2m 3m 4m 5m 6m


CT.M
180
170
160
150
CT.M
140
20
CT. V
10
0
CT. IX
10
20
CT. IX
30
LEO
SEX-
TANS
CRA
TER
HYDRA
ARGO
RVUS
Variabiles.
1m
2m
3m
4m
5m
6m

or Sadalmelik; Beta (β), or Sadalsuud; Epsilon (ϵ), or Al Bali, and Delta (δ), or Scheat. The larger part of the constellation lies south of the ecliptic, and the sun only passes through its narrower northern portion, although through the centre of the figure. Alpha is in the right shoulder, and Beta in the left, while Gamma, with a group of smaller stars near it, marks the overturned urn. These stars form a rather singular Y-shaped figure, or a triangle, with a relatively bright star within it, by which the constellation may readily be recognized.

In Greek mythology Aquarius represented Ganymede, the cup-bearer of the gods. It was also identified with Deucalion, who, like Noah, escaped from a universal deluge and finally came to dry ground on the top of Mount Parnassus. Aquarius is Dr. Seiss's symbol in the stars of Him who said, "If any man thirst let him come unto me and drink."

Zeta (ζ) Aquarii is a beautiful binary; magnitudes, fourth and fourth; distance, 3″; color of both stars, pale green. Psi (ψ) is double; magnitudes, fourth and eighth; distance, 50″; colors, yellow and blue.

Piscis Australis, or Austrinus

(CHART XII)

Below Aquarius the eye is caught by a conspicuous and lone first-magnitude star named Fomalhaut, or Alpha (α) of Piscis Australis, the Southern Fish. This fish is very distinctly marked out by Fomalhaut and six or seven smaller stars arranged in a long oval on the west. Fomalhaut is in the fish's mouth. It is

one of the four Royal Stars, important to navigators, and gains much by its solitary situation. Flaming above the southern horizon on a chilly autumn night, it attracts a degree of attention that would not be paid to it if it occupied a place in some richer region of the sky. It is like a distant watch-fire gleaming in the midst of a lonely prairie.

In the traditional figure of this constellation the fish is represented as drinking the water poured out of the urn of Aquarius. Besides the two names given at the head of this section, it is also sometimes called Piscis Meridionalis and Piscis Notius. A Greek legend associated it with the story of Venus's adventure on the banks of the Euphrates with the giant Typhon, when, to escape, she changed herself and Cupid into fishes. Dupuis identified it with the Syrian god Dagon. Dr. Seiss sees in it a symbol of the mystic union of Christ with His Church.

Pegasus

(CHARTS IV AND XII)

The great winged horse Pegasus is seen flying westward through the sky above Aquarius and the western fish in Pisces. This constellation, however, bears no resemblance to the outlines of a horse, and strikes the eye only by a large quadrangular figure called the Great Square of Pegasus. Three of its stars are of the second and one of the third magnitude. Beginning at the lower western corner of the square and running round towards the left,

they are: Alpha (α), also called Markab; Gamma (γ), also Algenib; Delta (δ), also Alpheratz; and Beta (β), also Scheat. Delta, or Alpheratz, is common to the constellations Pegasus and Andromeda, and is sometimes assigned to one and sometimes to the other. When counted as an Andromede, it bears the Greek letter alpha (α), implying its leadership in that constellation. This star, with Gamma, or Algenib, to the south, and Beta Cassiopei to the north, forms the line of the Three Guides, thus named because they lie very nearly on the prime meridian of the heavens, which passes through the vernal equinox, or first point of Aries, about 15° south of Algenib. The broad area of sky included within the square seems singularly devoid of stars. In a space of more than two hundred square degrees there are only six stars as bright as the fifth magnitude. But the square, large as it is, covers only the eastern third of the constellation. The nose of the imaginary horse is forty degrees west of Alpheratz, outstretched as if to touch the foal Equuleus. The star marking the nose, Epsilon (ϵ), bears the name Enif, derived from an Arabic word for nose.

The mythology of Pegasus is associated with one of the most interesting of the ancient legends of Greece—that of the birth of a white-winged horse from the blood of Medusa dropping into the ocean. This horse became the favorite of the Muses because from his hoof-print gushed their fountain on Mount Helicon. On another occasion when he touched the earth his magic hoof left a fountain called the Hippocrene, on the rocky hill of Acrocorinthus, and mod-

ern travellers may still see this fountain full of water on the very crest of the vast rock which towers eighteen hundred feet above the neck of the Isthmus of Corinth. The figure of Pegasus is found on Corinthian coins five hundred years before the Christian era. Longfellow represents the magic horse as paying an unexpected visit to a quiet New England village and being put into the pound as an astray:

And the curious country people,
Rich and poor and young and old,
Came in haste to see this wondrous
Wingèd steed, with mane of gold.

On the morrow, when the village
Woke to all its toil and care,
Lo! the strange steed had departed,
And they knew not when or where.

But they found upon the greensward,
Where his struggling feet had trod,
Pure and bright a fountain flowing
From the hoof-marks in the sod.

—*Pegasus in Pound.*

One of the old legends asserts that Pegasus, while visiting the earth, was caught by Bellerophon, who rode him through the air when he went to slay the Chimæra. This angered Zeus, who hurled Bellerophon from his seat after the conquest of the Chimæra, and never permitted Pegasus to stray earthward again —until the time of Longfellow, when there were no longer any heroes to ride him and when only poets could appreciate him. Dr. Seiss assures us, with

learned comments on the ancient names of this constellation and its stars, that Pegasus was meant to signify the Messenger of Glad Tidings.

The star Epsilon is double; magnitudes, second and eighth; distance, 138″; colors, yellow and violet. Sir John Herschel discovered a curious telescopic experiment which may be tried with Epsilon Pegasi. When the star is on the meridian the small component is below the brighter one. If, then, the tube of the telescope is swung a little from side to side, the small star will appear to vibrate like the bob of a pendulum. The suggested explanation is that the relative faintness of the small star causes it to affect the sense of vision less promptly than the bright one above it, so that it lingers behind in the apparent motion, and thus it seems to be swinging to and fro with reference to the other.

Lacerta

(CHART IV)

Directly north of Pegasus, and just on the meridian, we find the small constellation Lacerta, the Lizard. Hevelius formed it in the seventeenth century. It contains two stars of the fourth magnitude and ten of the fifth, but, although retained on all celestial charts, it possesses almost no interest, even for astronomers.

Cepheus

(CHART II)

Between Lacerta and the pole lies the first of a series of constellations, sometimes called the Royal

Family, and which commemorates the most romantic of all the legends of ancient times inscribed in the stars—the story of Andromeda and her rescue from the sea-monster.

This constellation, which contains no star much above the third magnitude, has, nevertheless, attracted attention from the beginning of recorded history.

> Nor shall blank silence whelm the harassed house
> Of Cepheus. The high heavens know their name,
> For Zeus is in their line at few removes.
> Cepheus himself by she-bear Cynosure,
> Iasid king, stands with uplifted arms.
>
> —*Aratus.*

The adjective "Iasid" refers to Iasion, the son of Zeus and Electra, from whom Cepheus was supposed to be descended. Cepheus was the King of Ethiopia, his wife was the celebrated Cassiopeia, and his daughter was the still more celebrated Andromeda. Their story will better be told in the next chapter. An association has been suggested, through the similarity of names, between Cepheus and Cheops, the builder of the Great Pyramid. Allen says that in China the Inner Throne of the Five Emperors was located somewhere in this constellation. For Dr. Seiss the story of Cepheus and his constellation represents the coming of the Redeemer as king.

The star Alpha (α), of between the second and third magnitudes, bears the name Alderamin, and marks the right shoulder. This will be the north-pole star for our descendants about 5600 years hence.

Beta (β), Alfirk, is a telescopic double; magni-

tudes, third and eighth; distance, 13″; colors, white and blue. Delta (δ) is double; magnitudes, four and a half and seventh; distance, 41″; colors, yellow and cerulean blue. In the double Xi (ξ) the magnitudes are fifth and seventh; distance, 5″.8; colors, white and blue or lilac. The star Mu (μ) is famous as Sir William Herschel's "garnet star." Its color, evident with a glass, is sensible to the naked eye. It is a variable, changing from the fourth to the sixth magnitude in a period of five or six years. Many small meteors radiate from Cepheus during the middle and latter part of June.

XII

CONSTELLATIONS ON THE MERIDIAN IN NOVEMBER

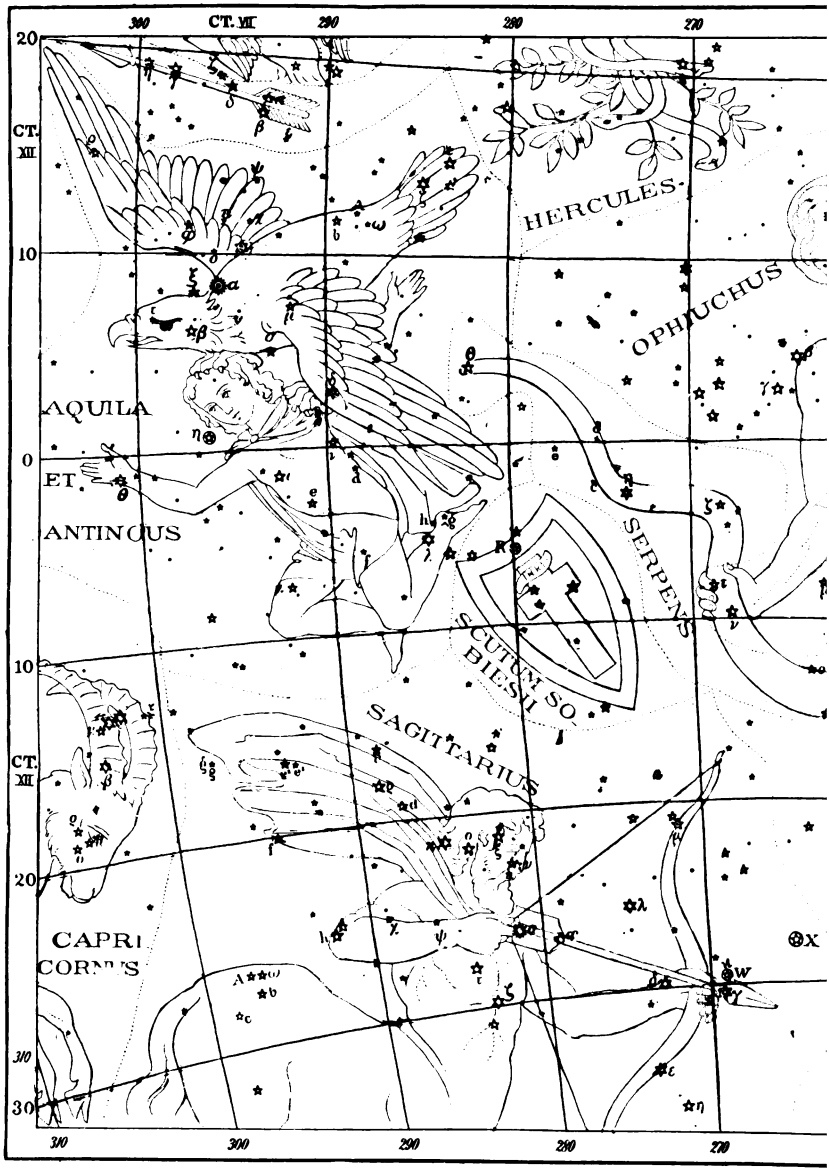
Pisces

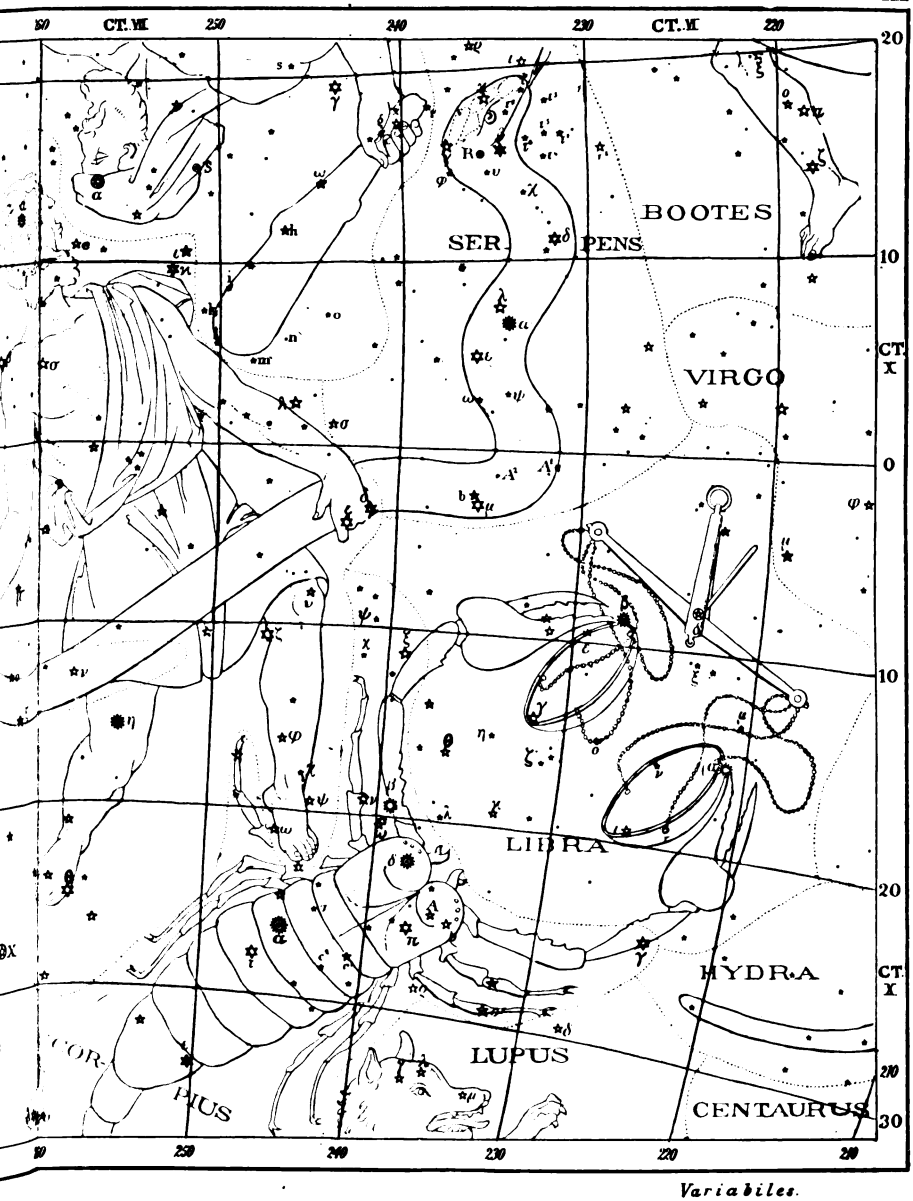
(CHARTS IV, VIII, AND XI)

PISCES, the Fishes, is the leading constellation of the zodiacal circle, the precession of the equinoxes having brought it into the position originally occupied by the first *sign* of the zodiac—*viz.*, Aries. The vernal equinox, or the point where the sun crosses the equator coming northward in the spring, is situated in Pisces. This is the "Greenwich of the sky," from whose longitude the right ascension of all the stars is reckoned. It is, of course, a crossing-point of the ecliptic and the equator, but this important spot is not marked by any conspicuous star, nor even by any noticeable grouping of stars.

It may be well to say here that usually a distinction is observed in speaking of the zodiacal *signs* and the zodiacal *constellations*, the former, notwithstanding their westward drift, indicating the true divisions of the zodiac, while the constellations change their places on this framework. Reckoned in this way, Pisces is the first constellation of the zodiac, since it

$\alpha = 260°$. $\delta = +8°$.





Variabiles.

1m 2m 3m 4m 5m 6m

now occupies the place of the first sign; Aries is the second, Taurus the third, Gemini the fourth, Cancer the fifth, Leo the sixth, Virgo the seventh, Libra the eighth, Scorpio the ninth, Sagittarius the tenth, Capricornus the eleventh, and Aquarius the twelfth.

The constellation Pisces is inconspicuous to the eye, but it occupies an enormous territory, some fifty degrees from east to west, and more than thirty degrees in its extreme north and south extension. The two fishes are represented as tied by the tails to the ends of a long ribbon, the course of which is fairly well marked by streams of stars, only one of which, occupying a knot near the middle of the ribbon, rises to the third magnitude. This is the Alpha (α), or leader, of the constellation, and is often called Al Rischa, and sometimes Nodus. There are eleven fourth-magnitude stars in the constellation, and eighteen of the fifth magnitude. Professor Sayce thinks that the double form of this constellation owes its origin to the extra month which was inserted into the Babylonian calendar every six years to make up for the fact that the year was divided into three hundred and sixty days. Like Piscis Australis, this constellation was associated with the story of Venus changing herself and Cupid into fishes to escape the pursuit of Typhon. Aratus's description of Pisces indicates that in his time the representation of the two fishes was the same as in our charts:

> Westward, and further in the south-wind's path,
> The Fishes float; one ever uppermost
> First hears the boisterous coming of the north.
> Both are united by a band.

Their tails point to an angle
Filled by a single goodly star,
Called the Conjoiner of the Fishes' Tails.
—*The Phainomena.*

Three conjunctions of the planets Jupiter and Saturn took place in Pisces in the year which was formerly assigned as that of the birth of Christ, and this has led to much mystical speculation concerning the Star of Bethlehem. Mr. Allen remarks that the conjunctions just spoken of strikingly agree in some of their details with St. Matthew's account of the mysterious star. Kepler, and Encke long after him, advocated the idea that this was in reality the celestial sign followed by the magi, but the revision of the Christian era throws the date of the conjunctions four years out. In 1881 Jupiter and Saturn were again in conjunction in Pisces, and the fact was not lost sight of by those (and they were not few, even in this age of science) who thought that that year was the epoch of the new dispensation and the sign of the millennium. Piazzi Smyth's curious measurements in the passages and chambers of the Great Pyramid, and the still more curious conclusions that he drew from them, added force to the superstition with which the advent of the year 1881 was greeted. Dr. Seiss avers that Pisces symbolizes "the two-foldness of the Church."

The star Alpha is a beautiful double; magnitudes, fourth and fifth; distance, 3″; colors, greenish-white and blue. The star 55 is double; magnitudes, fifth and eighth; distance, 6″.6; colors, yellow and deep blue. Psi (ψ) consists of two fifth-magnitude stars;

distance, 30″. In the double Zeta (ζ) the magnitudes are fifth and sixth; distance, 24″.

Andromeda

(CHART IV)

Lifting our eyes directly overhead, we see the Chained Maiden, Andromeda. The constellation is centrally on the meridian at nine o'clock in the middle of November. If Orion is the most brilliant of the constellations, Andromeda is the most romantic. It requires some effort to recognize the form of the celebrated heroine among the stars, but her story shines by reflection in all literatures.

The fact has already been mentioned that the star Alpheratz, in the northeastern corner of the Great Square of Pegasus, indicates the head of Andromeda. Three other conspicuous stars, the first of the third magnitude and the other two of the second, stretching in a long row northeastward from Alpheratz, mark the central line of the constellation. The first of these stars, Delta (δ), is in the left breast; the second, Beta (β), or Mirach, is in the girdle; and the third, Gamma (γ), or Almaak, marks the left foot, or left knee, according as the figure is drawn. A group of three fourth-magnitude stars and one of the fifth magnitude, about fifteen degrees north-northwest of Alpheratz, shows the right hand chained to the rock, while the left elbow is indicated by a fourth-magnitude star about eight degrees below Delta. Northwest of Mirach are two fourth-magnitude stars, also in the girdle, which serve as pointers to the glori-

ous Andromeda nebula, which may be caught as a mere wisp of light by the naked eye. It is near the northernmost of the two stars. Photographs of this nebula present a spectacle that defies description. It consists of a vast oblong central mass, the outer portion of which shows longitudinal gaps, and in one part a breaking-up into cumuli, while all around are ranged, ring within ring, great luminous ellipses, some of which seem to be contracting into globular forms. If Laplace could have seen these photographs he would have thought that the heavens had produced for him an irrefragable witness to the truth of his nebular hypothesis of the origin of worlds. More truly descriptive of this nebula than of the constellation (although he did not know it) is Kingsley's line—

> Spreading thy long white arms all night in the heights of the ether.

A new star blazed out in the nebula in 1885, and remained visible with telescopes for a year.

Although the Greek poetess Sappho referred to Andromeda, and although both Euripides and Sophocles wrote dramas about her, we must probably, says Mr. Allen, seek her origin far back of classical times, in the valley of the Euphrates.

The myth of Andromeda relates that she was the daughter of Cepheus and Cassiopeia, king and queen of Æthiopia. Cassiopeia offended Neptune by boasting herself as fairer than the sea-nymphs, and he sent a sea-monster to ravage the kingdom. An appeal was made to the oracle of Zeus at Ammon, but

the only relief obtained was a decree that the kingdom should be saved if the Princess Andromeda were given as a prey to the sea-monster. She was taken to the sea-shore and chained to a rock. The location is as fleeting as that of Shakespeare's island in "The Tempest," but Josephus declared that in his time the marks of Andromeda's chains were to be seen on the rocks near Joppa, and that near by on the shore the bones of the sea-monster were still shown. Awaiting her fate, and abandoned by her royal relatives, Andromeda remained by the shore until a rushing sound and the flight of frightened birds told her that the monster was approaching. She hid her eyes, trembling, when suddenly,

> Like peal of thunder from unclouded sky,
> A sudden neighing rolls and echoes nigh.
> Her eyes unclose; horror and joy are one,
> For she beholds, in whirling flight and free,
> The wingèd horse, upbearing Zeus's son,
> Throw his vast shade of azure on the sea.

It was Perseus, mounted on Pegasus, returning from the conquest of the Gorgon Medusa. His diamond-hilted sword glittered as he darted upon the monster and transfixed him. But, according to some accounts, he only gained the victory by holding before the eyes of the monster the bleeding head of Medusa, the sight of which, with its snaky locks, froze all who looked upon it into stone.

The sea-monster having been destroyed, Perseus unchained the maiden and conducted her back to her father's court. The reward of his valor was the

traditional one in all such cases—he received the hand of the rescued maiden in marriage.

When the happy lives of all the actors in this drama were ended, Zeus, not sorry, perhaps, to thwart Neptune, played his customary part by translating them to the stars:

And there, a woful statue form, is seen
Andromeda, parted from her mother's side. Long, I trow,
Thou wilt not seek her in the nightly sky,
So bright her head, so bright
Her shoulders, feet, and girdle.
Yet even there she has her arms extended,
And shackled, even in heaven; uplifted,
Outspread eternally, are those fair hands.

—*Aratus.*

But other poets assert that Zeus was so delighted with the triumph of his son that he did not wait for death in this case, so that Perseus and Andromeda had the peculiar happiness of seeing their new-made constellations blazing overhead, as, on Pegasus's back, they flew away from the scene of the encounter.

The splendent wingèd horse in noiseless flight,
From out his nostrils blowing clouds of fume,
Bears them, with quivering of his every plume,
Across the starry ether and blue night.
Like two enormous cloaks the wind swells wide
The pinions, which, as through the stars they glide,
Keep the clasped lovers nested from the cold,
While as their throbbing shadows they descry,
From Aries to Aquarius they behold
Their constellations flaming in the sky.

—*José M. Heredia* (*Taylor's trans.*).

Having thus, as it were, seen their own obituaries spread upon the evening edition of *The Universe* by the hand of Jove himself, they retired to Queen Cassiopeia's court, and to their first-born was given the name Perses, from whom the proud Persian kings, many centuries afterwards, boasted their descent.

In Dr. Seiss's mythology Andromeda and Cassiopeia were both intended for prophetic symbols of the Christian Church.

The star Gamma, in the maiden's foot, is perhaps the most beautiful triple star in the heavens. Any fairly good telescope shows that it consists of a golden yellow and a deep-blue star, of magnitudes third and sixth, 10″ apart, but a very powerful glass shows that the smaller star is itself double, having an eighth-magnitude companion, which has sometimes been described as green. This is a binary pair, and the distance, in 1907, was 0″.48. In 1893 it was only 0″.17.

Cassiopeia

(CHART II)

Zeus gave to Andromeda's mother a more beautiful constellation than that which he assigned to her. It lies between the constellations of Andromeda and her father, Cepheus, and is conspicuously marked by five bright stars forming an irregular letter "W," with the open part turned towards the pole. It is situated on the opposite side of the pole from the Great Dipper, so that when one rises the other sinks, and *vice versa*. These stars are Alpha (α), Beta (β), Gamma (γ), Delta (δ), and Epsilon (ϵ). A straight line drawn

from Zeta (ζ) Ursæ Majoris through Polaris hits Delta Cassiopeiæ. The true pole is situated about a degree and a quarter from Polaris on the side towards Ursa Major. Thus the position of the pole can be ascertained with approximate accuracy at any hour of the night.

Some of the Greeks called the constellation the Laconian Key, from the peculiar shape of the figure already described. This is the origin of Aratus's description:

> Heaven-troubled queen, with scanty stars,
> But lustrous in the full-mooned night, sits Cassiopeia.
> Not numerous, nor double-rowed,
> The gems that deck her form,
> But like a key which through an inward-fastened
> Folding-door men thrust to knock aside the bolts,
> They shine in single zig-zag row.
>
> —*The Phainomena.*

Several of the stars in the "W," or the Key, have individual names. Alpha is Schedar, Beta is Caph, and Delta is Ruchbar. Theta (θ) in the queen's elbow is Marfak. The fourth-magnitude star Kappa (κ) is interesting as indicating the place in the sky (about 1° north of Kappa) where the famous new star of Tycho Brahe suddenly blazed out in the year 1572. This was one of the most brilliant temporary stars on record, and attempts have been made to associate it with the Star of Bethlehem, on the supposition that it appeared in 945 and 1264, and has, therefore, a period exceeding three centuries, so that one of its epochs of visibility would fall about the

time of the birth of Christ. But it has never been seen since it faded from sight in Tycho's day, although a small telescopic star close to the place which it occupied has been suspected of identity with it. This star is the Al Aaraaf of Edgar Allan Poe's poem:

> Dim was its little disk, and angel eyes
> Alone could see the phantom in the skies
> When first Al Aaraaf knew her course to be
> Headlong thitherward o'er the starry sea.

Beta and Gamma are of the second magnitude; Alpha, Delta, and Epsilon of the third. In all, Cassiopeia contains two stars of the second magnitude, three of the third, six of the fourth, and twenty-one of the fifth, or near.

The constellation is rich in telescopic objects. Sigma (ς) consists of two stars, one blue, the other greenish; magnitudes, fifth and seventh; distance, $3''$. Eta (η), of magnitudes fourth and seventh, consists of a white and a purple component; distance, $5''$. Iota (ι) is a beautiful triple; magnitudes, fourth, seventh, and eighth; distances, $2''$ and $7''.5$. There are many telescopic star-clusters in the constellation.

XIII

CONSTELLATIONS ON THE MERIDIAN IN DECEMBER

Aries

(CHART IV)

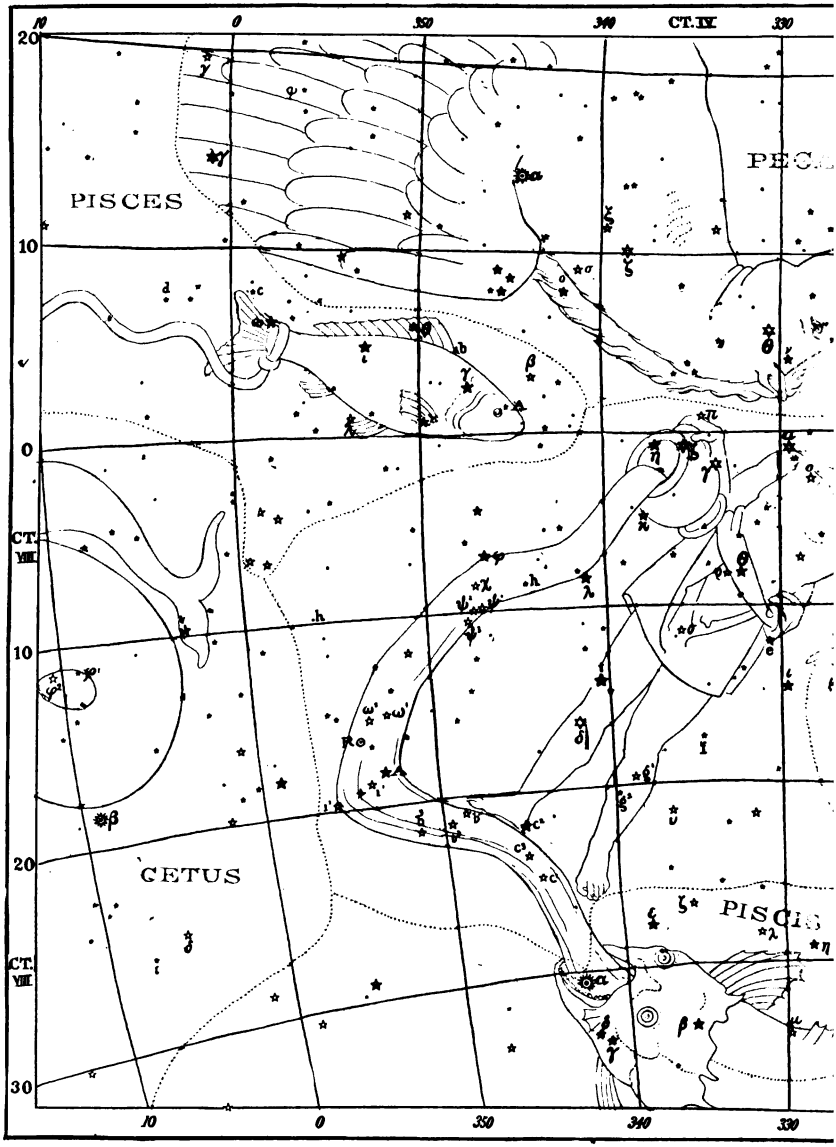
ARIES, the Ram, is the second constellation of the zodiac. As before remarked, Aries is the *first sign*, and this sign has now drifted back into the constellation Pisces. The Ram is a small constellation, only some twenty-five degrees in its extreme length, lying between the northern fish of Pisces and the Pleiades in Taurus. Two stars in the head, Alpha (α), or Hamal, and Beta (β), or Sheratan, are its only conspicuous brilliants. They are in the western part of the constellation. Gamma (γ), or Mesarthim, a little below Sheratan, is of the fourth magnitude. The tail is indicated by a group of three fourth and two fifth magnitude stars about ten degrees south of west from the Pleiades.

In mythology this was the ram of the Golden Fleece.

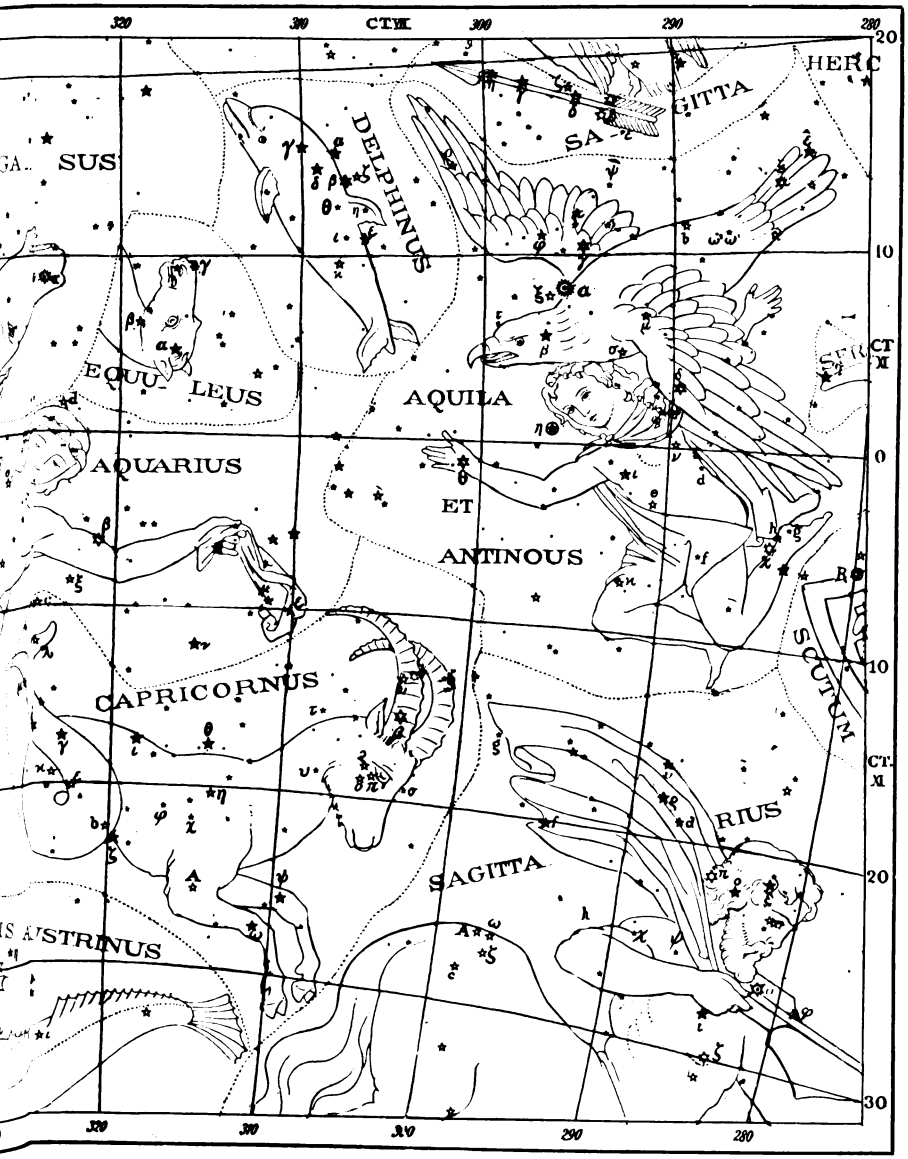
> The princely Ram, glittering in golden wool.
> —*Manilius.*

He flew from Colchis with Phrixus and his sister Helle on his back, but Helle's head was giddied by

$\alpha = 325°$, $\beta = +8°$.



1m 2m 3m 4m 5m 6m



Variabiles.

1m 2m 3m 4m 5m 6m

the swift motion, and she fell off and was drowned in the narrow sea now called the Hellespont. Aries has also been associated with the story of the ram into which Zeus changed himself to escape the pursuit of the giants. He fled to Egypt, and there the constellation was called Jupiter Ammon. But in Chaldea, where it is supposed to have had its origin, this celestial ram was simply representative of the favorite animal of the shepherds, and was selected as the leader of the zodiac, a position which he has ever since retained. The star Sheratan marked the vernal equinox in the time of Hipparchus. Aries bore many titles indicative of its rank as leader of the year in ancient times. It was called Prince of the Zodiac, Prince of the Celestial Signs, and Leader of the Host of the Zodiac. The history of the constellation appears to run far back of the time when the precession of the equinoxes had placed it at the head of the monthly signs. Berosus, who was priest of Belus at Babylon in the time of Alexander the Great, and whose predictions about the destruction of the world we have noticed, said that the ancients—*i. e.*, those who were ancient to him—believed that the world was created when the sun was in the constellation Aries. This was long before Aries had assumed the leadership which (as a constellation, not as a sign) it has since lost. Dr. Seiss naturally finds in Aries a symbol of the Lamb of the World. What he says of the ancient worship of Aries is interesting:

The Egyptians celebrated a sacred feast to the Ram upon the entrance of the sun into the sign of Aries. They prepared for it before the full moon next to the spring equinox,

and on the fourteenth day of that moon all Egypt was in joy over the dominion of the Ram. The people crowned the lamb with flowers, carried him with extraordinary pomp in grand processions, and rejoiced in him to the utmost. The ancient Persians had a similar festival of Aries. For all this it is hard to account except in connection with what was prophetically signified by Aries.

The star Gamma, or Mesarthim, was the first double star discovered. Robert Hooke, following a comet with his telescope in 1664, happened to pass over Mesarthim, and was astonished to see it double. The magnitudes are fourth and fourth; distance, 8″.5. Lambda is a wide double; magnitudes, fifth and eighth; distance, 37″; colors, white and lilac. Epsilon is a close double; magnitudes, fifth and sixth; distance, 1″.25.

Triangulum

(CHART IV)

The little constellation called the Triangle, northwest of Aries, and near the feet of Andromeda, is very ancient. Aratus calls it Deltoton, from its resemblance to the Greek delta (Δ). The corners of the elongated triangle are marked by the stars Alpha, Beta, and Delta. Beta is of the third magnitude, and Alpha and Delta are of the fourth. Alpha, no doubt, has faded. The first asteroid to be discovered, Ceres, was found in Triangulum in the year 1801.

Perseus

(CHARTS II AND IV)

The constellation Perseus brings us back to the Royal Family of the sky.

He in the north-wind stands gigantic,
His right arm stretched towards the throne
Where sits the mother of his bride. As one bent on some high deed,
Dust-stained he strides over the floor of heaven.

—*Aratus.*

The dust that sparkles on the hero's armor consists of the powdered starlets of the Milky Way, which is nowhere richer than here. Perseus was a celebrated hero before he rescued Andromeda. His conquest of the Gorgon Medusa is one of the finest stories of Greek mythology. The son of Zeus and Danæ, he became the favorite of the gods. When others were contending with rare gifts for the favor of King Polydectes, at whose court he lived, Perseus sought to outdo them all by bringing the head of Medusa to throw at the king's feet. It was an adventure worthy of Hercules, and to undertake it with any chance of success he had to borrow the helmet of invisibility from the god of the lower world, the sandals of swiftness from Hermes, and the buckle of wisdom from Athene. Furnished also with a magic sword set with diamonds, and, according to some, riding Pegasus, loaned by Zeus, he hastened to the encounter. Even then he would have failed, and have been turned to stone by the petrifying glances of the Gorgon, had not Athene's polished buckle served as a mirror in which he could see his enemy without facing her. With a backward stroke he severed Medusa's terrible head, with its hissing snakes for hair, and was on his way to bestow the dreadful gift upon King Polydectes, when he chanced to espy Andromeda in her plight,

and stopped for another and a more romantic exploit.

Perseus still carries Medusa's head, which is represented in the sky by a group of five or six stars, the largest of which is the celebrated Algol, the so-called Demon Star, or the Winking Demon, which every two days, twenty hours, and forty-nine minutes suddenly begins to fade away, until, in the course of three or four hours, it loses four-fifths of its light. A few minutes later it begins to brighten, and in the course of the next three or four hours it regains all of its former brilliancy. When at its brightest, Algol is nearly of the second magnitude; when faintest, it is not far above the fourth. The cause of these singular variations has been shown to be an enormous dark body, as large as our sun, revolving around Algol at a distance of only about three million miles, and regularly eclipsing it, as seen from the earth. The entire course of the changes undergone by Algol can be watched with the naked eye.

Among the Hebrews, Algol was said to represent Adam's mysterious first wife, Lilith, but it is only a matter of guesswork that this identification had any connection with the star's strange variability.

On February 22, 1901, a marvellous new star was discovered by Dr. Anderson, of Edinburgh, not very far from Algol. No star had been visible at that point before. Within twenty-four hours the stranger had become so bright that it outshone Capella. In a week or two it had visibly faded, and in the course of a few months it was hardly discernible with the naked eye. Its decline continued, and by the end of the

year it could only be seen with telescopes. The next year the star underwent a wondrous transformation. Its spectrum assumed the nebular type, and great nebulous rings or spirals were photographed around it. Still later it resumed the stellar type, and it is still (1908) visible as a star of the ninth or tenth magnitude. The career of this star recalls that of Tycho which blazed out in Cassiopeia in 1576. In both cases the collision hypothesis has been suggested to account for the marvel. The eccentric changes undergone by Nova Persei, alternately fading and brightening — while, upon the whole, losing light — have been regarded by some as indicating that a star had run into a nebula or a vast cloud of meteoric matter, the successive collisions producing the outbursts of light. Like all variable and temporary stars, Nova Persei turned red as it faded.

Algol bears the Greek letter beta (β) in the constellation Perseus. The Alpha of the constellation is situated about ten degrees northerly from Algol, in the midst of a curved row of stars embedded in the Milky Way and marking the armor-clad body of the hero. Alpha's distinctive name is Algenib. Following the course of the Milky Way towards Cassiopeia, the eye is caught by a sparkling patch which an opera-glass will resolve into a swarm of minute stars. This indicates the hand in which Perseus bears the diamond-hilted sword. This object is sometimes called Chi (χ) Persei. In reality it consists of two clusters of stars like two swarms of bees encountering in mid-air. They have excited the admiration of all astronomers. "These two gorgeous clusters," is Webb's

descriptive phrase; "The glories of χ Persei," is Proctor's tribute; "One of the most brilliant objects in the heavens," wrote Admiral Smyth. Sir William Herschel here tried one of his famous "star gauges," but with his most powerful telescope he could not reach the bottom of what seems to have been regarded by him as a sort of well filled with stars, for he thought that it extended out into space to a depth far greater than its width. I remember once showing this object with a small telescope to a person who had never before looked into an astronomical glass, and his sudden start and exclamation of amazement were a tribute to the wonder-stirring power of the starry universe.

The mythology of this constellation has already been sufficiently indicated. No one will be surprised that Dr. Seiss makes Perseus the symbol of the Redeemer of mankind and the slayer of the Evil One, the latter being represented by Algol. He derives the name Perseus from a root signifying the Breaker, and, summing up the old myths, he says:

> No natural events in the seasons or in the history of man could ever serve as a foundation for such a story as this. Here is a divine-human son, begotten of a golden shower from the Deity, a child of affliction and persecution from his very birth, but predestined by the heavenly powers to live and triumph. . . . He is winged, and given a diamond sword, as Heaven's messenger and herald, to undo the powers of evil and administer deliverance and prosperity.

The double star Eta (η) has components of magnitudes fourth and eighth; distance, 28″; colors, white and pale blue. In Epsilon (ϵ) the magnitudes are

third and eighth; distance, 9″. The eighth-magnitude star is variable, and some observers have said that its color changes from blue to red as it fades.

Cetus

(CHART VIII)

The great constellation of Cetus, the Whale, is now mostly past the meridian in the south, the head, which is turned eastward, lying just under Aries. The constellation is about fifty degrees in length from east to west, and nearly as much in its greatest extension north and south. Its leading star, Alpha (α), or Menkar, in the head, is of less than the second magnitude. Gamma (γ), six degrees west of it, in the direction of Alpha Piscium, is of the third magnitude. Some twenty-five degrees southwest of Menkar four third-magnitude stars, in the body of the Whale, mark the outlines of the upturned bowl of a dipper. Farther west and south is a second-magnitude star, Beta (β), in the tail, which is also called Denib Kaitos. Much of this constellation is comparatively a blank, owing to the absence of conspicuous stars. Heis assigns to Cetus two second-magnitude, six third-magnitude, seven fourth-magnitude, and twenty-four fifth-magnitude stars, but all of them, as is usual, vary much from the standard.

Cetus was identified by Aratus with the sea-monster sent to devour Andromeda:

> And yonder, distant from her cowering form,
> The on-coming monster scares Andromeda.

She in the blasts of Thracian Boreas
Is stationed, while the south-wind brings her foe.
—*The Phainomena.*

In earlier times it seems to have been regarded as some kind of leviathan without connection with the story of Andromeda. Allen suggests that it may have represented the ferocious Tiamat of the Chaldean myths. The creature seems about to plunge into the waters of the river Eridanus. In the seventeenth century it was considered to be a symbol of Jonah's whale, and also of Job's leviathan. It is hardly necessary to say that Dr. Seiss finds in it the Apocalyptic Dragon, "the Old Serpent which is the Devil and Satan."

The most interesting star in Cetus is Omicron (*o*), celebrated by the name Mira, the first variable star ever recognized as such. Its changes were noticed with great astonishment by David Fabricius, an amateur astronomer of Germany, in 1596. Mira when brightest sometimes exceeds the second magnitude (this occurred in December, 1906), and when faintest it is far beyond the range of the naked eye. Its average period is about three hundred and thirty-one days, but this period is variable to the extent of nearly a month. Sometimes the star fails to brighten when expected to do so. In the seventeenth century it once remained invisible for four years. Generally when at maximum it does not exceed the third or fourth magnitude; its occasional outbursts are, therefore, all the more surprising. Its color, especially when fading, is red, and its spectrum shows blaz-

ing lines when its light is gaining. The semblance to a gigantic conflagration is startling. The cause of the variations of Mira remains unknown, but the phenomena most closely resemble those observed in temporary stars like Nova Aurigæ and Nova Persei. Some think that Mira represents the closing stages of sunspottedness.

Zeta is a wide double; magnitudes, third and ninth; distance, 185″. Gamma is a very beautiful double; magnitudes, third and seventh; distance, 3″; colors, straw-color and blue.

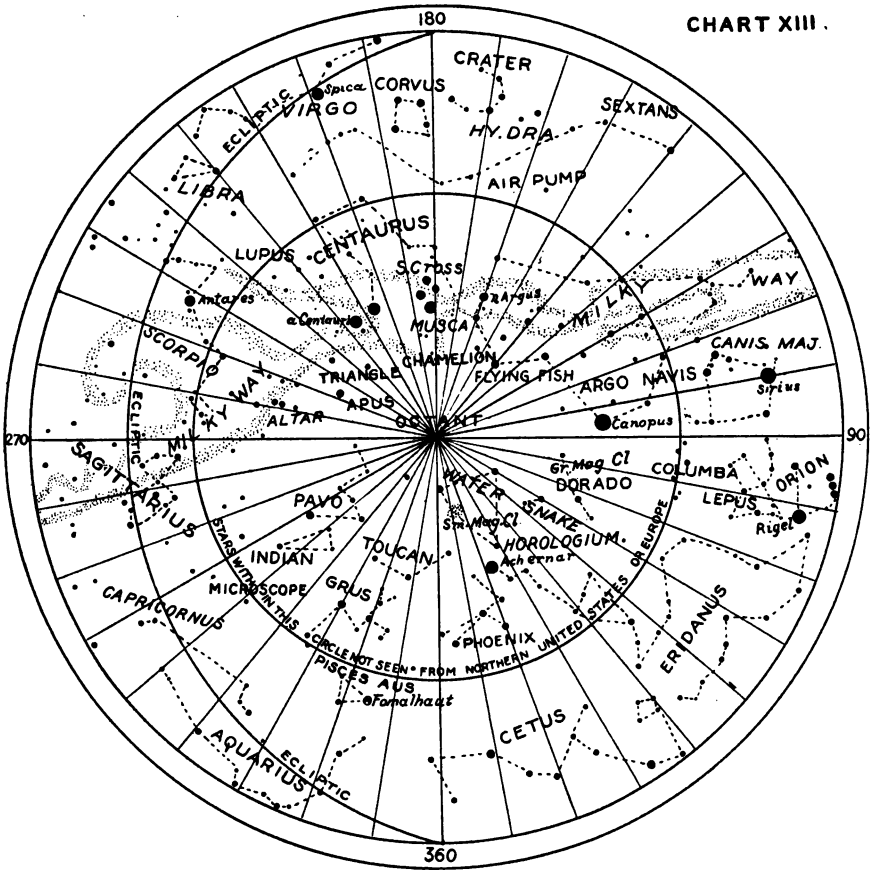
XIV

THE SOUTHERN CONSTELLATIONS

Argo Navis

Sternward she glides, like to a ship whose helm
Her crew have turned to landward,
Coming to anchor. All the oars back water,
And lapping surges splash upon the strand.
Thus sternward Jason's Argo makes her way,
Spectral her frame, and starless from the prow
To the central mast, but radiant all her after-hull.
—*Aratus.*

IN Chart XIII the whole southern hemisphere of the heavens is represented. The inner circle is placed about thirty-five degrees below the equator, and the constellations below or within this circle are circumpolar for the inhabitants of the southern hemisphere, and are not observable from median northern latitudes. Inasmuch as these stars are invisible for the majority of the readers of this book, the constellations are not represented by outlines, but their places and principal stars are shown. Parts of those lying close to the circle are visible from the Southern United States and Southern Europe, and they can be recognized by observing their position with reference



THE SOUTHERN CONSTELLATIONS.

to the well-known constellations bordering the zodiac and the equator.

Thus the brilliant Canopus, in Argo Navis, which can be seen from the Gulf States, lies about thirty-five degrees south of Sirius, in Canis Major. In Greek mythology, Argo Navis represented the ship built by Argo for Jason when he sailed in search of the Golden Fleece. Its bow is said to have been lost in passing through the Bosporus, and in the sky the ship is represented without a bow. A considerable portion of Argo Navis is above the horizon for Northern observers, but the more important part of the constellation lies far south. It is so extensive that astronomers, for purposes of reference, have divided it into three parts —*viz.*, Carina, the Keel; Puppis, the Stern; and Vela, the Sail. Canopus, the Alpha (α) of the whole constellation, is in the part called Carina. This star, which is second to Sirius only in brilliancy, and which has even been thought by observers in the southern hemisphere to outshine the Dog Star, has attracted a great deal of attention recently on account of the enormous actual magnitude that its brightness, combined with its vast distance, shows that it must possess. Professor Newcomb places it in what he has called the X class—*i. e.*, stars whose intrinsic brilliancy exceeds the sun's *at least ten thousand times!* Rigel, in Orion, is another star falling into this rank, but it does not follow that Rigel and Canopus are anything like equal. If Canopus is ten thousand times more brilliant than the sun, it is two hundred and fifty times more brilliant than Sirius, which equals only forty suns. Sirius outshines Canopus to our eyes simply

because it is much nearer to us. Basing the speculation on the immense magnitude of Canopus, some have suggested that it may be the actual centre of the universe, but there are no good grounds for such a belief. Canopus belongs to the same stellar type as Sirius, and shines with the same electric blue-white beams.

Canopus has been worshipped in many countries, such as Chaldea, Egypt, and China. Carlyle speaks of its worship by the Arabs in Mohammed's time, and finds an excuse for his hero to follow the example of his countrymen in the "wild, blue, spirit-like brightness" which the star exhibits when seen glittering above the sandy deserts of the South. It was Mohammed's star, as Venus seen by daylight is said to have been Napoleon's.

In Egypt, Lockyer has found many temples—at Edfu, Philæ, and elsewhere — oriented to Canopus when it rose just before sunrise at the autumnal equinox. Other temples—as, for instance, two at Karnak —pointed to its place of setting. Like Sirius, it has been identified with the Egyptian Osiris.

The other conspicuous stars of Argo Navis are farther east, lying in and along the Milky Way. Of these the star Gamma (γ), of the second magnitude, is notable as being the only bright star in the heavens which shows the Wolf-Rayet type of spectrum—*i. e.*, a continuous spectrum crossed by brilliant white instead of dark lines. It would seem that the atmosphere of such stars must be brilliantly incandescent. Another notable star is Eta (η), a most wonderful variable. Sometimes it becomes as brilliant as Sirius,

at other times it is invisible to the naked eye. Its period of change extends over many years, and is very erratic. Eta is surrounded by a strange nebula, called by Sir John Herschel, from its shape, the Key-hole Nebula. This, too, like the wonderful star involved in it, appears to be variable.

The South Pole

Between Canopus and Lepus, below Orion, lies the little constellation Colomba, the Dove, or Noah's Dove, mentioned in a preceding chapter. This, like most of the southern constellations, is of modern origin. Some of these, such as the Flying Fish, the Chameleon, the Air-Pump, and the Octant, are in themselves hardly worth mentioning for our purposes; but the Octant is interesting as being the antarctic equivalent of Ursa Minor, since it surrounds the southern pole of the heavens. There is, strictly speaking, no south polar-star, the nearest naked-eye star to the pole being hardly above the sixth magnitude. It is interesting, however, to know that when the brilliant Vega becomes the North Polar Star, about eleven thousand years hence, Canopus will be sufficiently near the south pole of the heavens to serve as a southern Polaris. Another curious fact associating these two brilliant stars is that the point in space from which the proper motion of the solar system is carrying us is situated not many degrees from Canopus, while the point towards which we are travelling is equally near to Vega.

The Southern Cross

This world-famous constellation lies exactly south of Crater, at a distance of about thirty degrees from the south pole. The precession of the equinoxes is carrying the Cross slowly southward, and it is a curious fact, to which Mr. Allen has called attention, that this constellation was last seen on the horizon of Jerusalem about the time of the Crucifixion. The Southern Cross did not receive its name, however, until after it had attracted the attention and excited the admiration of the early circumnavigators. It seems to have been named early in the sixteenth century. Dante's lines in the first canto of the "Purgatory" have often been supposed to refer to this constellation (not then called the Cross), because of its four bright stars:

> To the right hand I turned and fixed my mind
> On the other pole, attentive, where I saw
> Four stars ne'er seen before save by the ken
> Of our first parents. Heaven of their ray,
> Seemed joyous. O, thou northern site, bereft
> Indeed, and widowed, since of these deprived.
>
> —*Carey's translation.*

Amerigo Vespucci, on his first voyage, saw the Cross, and exultingly wrote that he had beheld Dante's "four stars." As other navigators pressed into the Southern seas, the fame of the *Croce maravigliosa*, as Pigafetta called it, spread over the world. Pigafetta thought it more glorious than all the other constellations. It appeared on a celestial globe by

Mollineux in 1592. Acosta, in his history of the West Indies, published in 1590, told how the Spanish settlers were accustomed to use the Southern Cross as a clock, reckoning the hour by its inclination to the horizon. Readers of the romance of *Paul and Virginia* will recall a reference to this use of the constellation of the Cross. The intensity of religious feeling in the time of the great geographical discoveries no doubt added immensely to the interest felt in the Southern Cross, as well as to the appreciation of its beauty by those lucky enough to see it. Its splendor lost nothing in their descriptions, and it soon captured the imagination of all Christendom. Yet its stars had been known to the ancients when the constellation shone over the middle northern latitudes, and they had not, apparently, given it a separate name. It was a part of the constellation Centaurus in Hipparchus's time. Essentially it is a constellation associated with the days of discovery and early conquest in America.

> Thou recallest the ages when first o'er the main
> My fathers unfolded the ensign of Spain,
> And planted their faith in the regions that see
> Its imperishing symbol ever blazoned in thee.
>
> —*Mrs. Hemans.*

Its renown is still so wide that few travellers visit the southern hemisphere without recording their first impressions of this constellation.

The Southern Cross consists essentially of four bright stars arranged as if at the ends of the two sticks of a kite, somewhat awry. The larger beam,

about six degrees in length, points to the pole. The four stars are, respectively, of the first, second, second, and third magnitudes. The largest star, Alpha (α), is at the base of the figure. Gamma (γ), of the second magnitude, at the top of the cross, is orange-colored. The other stars are white. Alpha is a beautiful telescopic double.

A famous telescopic object in the Southern Cross is the colored cluster surrounding the little star Kappa (κ). Sir John Herschel, the discoverer of this object, compared it to "a gorgeous piece of fancy jewelry," on account of the many colors displayed. There are several red stars, and others imitating emeralds, sapphires, and topazes. Different observers since Sir John Herschel's time have been differently impressed by this curious cluster, some describing it as exquisitely beautiful, and others finding that the only colors especially noticeable are the reds. I have noticed a surprising difference in the eyes of persons observing star colors. Some, apparently not color blind in ordinary circumstances, can see little or no color in a star where it is perfectly obvious to others.

Centaurus

There is a second Centaur in the southern sky, who, although he lacks the distinction enjoyed by his rival Sagittarius of belonging to the zodiacal twelve, makes upon the whole a more notable figure, although situated too far south to be seen from our latitudes. The constellation Centaurus surrounds the Southern Cross on three sides, and extends north of it to the coils of Hydra. It faces eastward, and is rep-

resented as charging, with a levelled lance, either at the Wolf, just ahead of it, or at the more formidable Scorpio, farther east and north. The constellation is fabled to represent the Centaur Chiron, who was the best of his race, the favorite of Apollo and Diana, and the instructor of Æsculapius in medicine and the chase, of Jason, and of the young Achilles, who was brought up under his care in a cave on Mount Pelion. Chiron tried to make peace between Hercules and the other Centaurs. Being struck by a poisoned arrow, he magnanimously offered to die in the place of Prometheus, and the gods accepted his sacrifice and put him among the stars. In antiquity, Chiron was believed to have invented the constellations.

Centaurus is especially interesting for containing the nearest to us of all the stars, the celebrated Alpha Centauri. This is a very brilliant star of nearly the zero magnitude, ranking next to Canopus. Its parallax is only $0''.75$, equivalent to a distance of four and one-third light years, or, say, twenty-six millions of millions of miles. Alpha Centauri is a binary, the smaller star being itself almost of the first magnitude. Taken together, the intrinsic brilliancy of the two stars is four times that of the sun. The spectrum indicates a stage of evolution between that of Sirius and that of the sun. Alpha Centauri was a prominent object of temple worship in Egypt.

Alpha and Beta Centauri, the latter of the first magnitude, make a noble pair, only about five degrees apart, and they are sometimes called the Southern Pointers, since they indicate the position of the Southern Cross.

Ara

Directly south of the tail of Scorpio stands the celestial altar, Ara.

> About that Altar ancient Night,
> Pitying human woes in ocean storms,
> Has raised a beacon.
>
> —*Aratus.*

The poet refers to the ancient importance of this constellation as a weather portent. When black clouds were seen at nightfall forming like smoke above its stars, the sailors took warning and stayed in harbor. But for its antiquity the constellation would hardly demand notice, for its stars are few and small. The prominence of the name in ancient times has led to the suspicion that some other group of stars was, at first, called the Altar. Yet the constellation described by Aratus is the same one that bears the name at the present time.

The Triangle

The Southern Triangle is a much more conspicuous object in the sky than its northern namesake near Andromeda. It is an invention of the sixteenth century, like the Southern Cross, and Bayer called it the Three Patriarchs. One of its stars is of the second, and the other two of the third magnitude. In the Northern Triangle the brightest star is of the third magnitude. The Southern Triangle was much noticed by the early navigators in southern seas.

Grus and Toucan

South of Capricornus and the Southern Fish is a group of modern constellations, including Grus the Crane, Toucan, Pavo the Peacock, and the Indian, of which Grus is worthy of special mention because its most conspicuous star, Alpha (α), of the second magnitude, can be seen from our lower latitudes flaming southwest of Fomalhaut. In former times Grus was a part of the Southern Fish, and then the star Alpha bore the name of the Bright One. Some of the early Spanish navigators called Grus the Flamingo, and they imagined it flying and striking with its long bill at the Southern Fish.

Toucan contains two notable star clusters. One of these was described by Sir John Herschel as the richest and largest object of the kind in the heavens. A later observer, Professor Bailey, of the Cambridge Observatory, has counted 2235 stars in the centre of the cluster, several of them being variables. Variable stars are numerous in many other clusters.

The second cluster in Toucan was described by Sir John Herschel as containing a nuclear mass of ruby stars at the centre, surrounded by white ones. Later observers have not noted the difference of color remarked by Herschel.

The Phoenix

Southeast of Fomalhaut, and just above the horizon in the latitude of New York in the middle of November, may be seen the bright second-magnitude

star Alpha (α), in the constellation Phœnix. The Arabs associated this constellation with the ostrich, but Bayer gave it the name of the Phœnix in 1603. Its principal star lies very close to the equinoctial colure, and is on the meridian with the sun at the opening of spring. On this account Mr. Allen thinks that the name Phœnix was very appropriately bestowed, since the fabled Phœnix renewed its life at the opening of the Great Year of the ancients, beginning at noon of the day when the sun entered Aries, and thus the astronomical symbolism of the constellation names is, in this instance, preserved.

The Southern Eridanus

In describing the constellation Eridanus, the starry river which takes its rise from the begemmed sandal of Orion, it was remarked that the chief star of the constellation is not visible from northern latitudes. It is found southeast of the Phœnix, about thirty-two degrees from the south pole, and is one of the most brilliant stars in the sky, equal to Rigel, Capella, Vega, and Arcturus. It bears the name Achernar, from the Arabic, meaning the End of the River. It is another star of the Sirian type, and, having a very small parallax, must be of enormous intrinsic brilliancy. In early times Eridanus was sometimes called the Ocean, and sometimes the River of Ocean. It has also at different times been identified with various famous rivers other than the Po. Aratus knew it only as the River. Thus, describing the rising of Cetus, he says:

And now the River-flood's first winding reach,
The becalmed mariner may see in heaven
As he watches for Orion, to espy if he hath aught to say
Of the night's measure or the slumbering winds.
—*The Phainomena.*

In Egypt it was associated with the Nile, and in Chaldea with the Euphrates.

The Magellanic Clouds

Almost directly south of Achernar, and about half-way to the pole, in the constellation called Hydrus, or the Watersnake, lies the smaller of the famous Magellanic Clouds, or Cape Clouds. This is the Nubecula Minor. Its greater companion, the Nubecula Major, is seen in the constellation Dorado, the Goldfish, half-way to Canopus. These luminous clouds, which resemble detached portions of the Milky Way, from which they are, however, far removed, excited the astonishment of early navigators of the southern oceans and shared attention with the Southern Cross.

The Nubecula Minor is the brighter of the two, covering about ten square degrees on the sky. Flammarion enumerates in it 37 separate nebulæ, 7 star clusters, and 200 individual stars. The Nubecula Major, which is very faint in the presence of the full moon, contains, according to the same authority, 291 separate nebulæ, 46 star clusters, and 582 individual stars. It covers an area of about forty square degrees. All around these singular clouds the sky is curiously dark and vacant, as if its contents had been swept into these heaps.

The name Magellanic Clouds, or Magellan's Clouds, was given to them because of the description which the great circumnavigator furnished of these phenomena on his voyage. But they were known before his day, and were called the Cape Clouds on account of being seen by those who visited or rounded the Cape of Good Hope. Humboldt thought that the larger cloud was probably the White Ox of the Arabs, and he remarks that in Southern Arabia, especially in the interior of the country, where the atmosphere is very dry and the sky of a deep azure, the Magellanic Clouds must be notable phenomena. The singular idea was once entertained that these clouds were parts of the Milky Way which had been broken off and drifted away, and the gaps which they had left were even pointed out. There is no ground whatever for this notion. In their intermingling of nebulæ and star clusters they resemble certain regions of the Milky Way that have been photographed by Barnard in the constellation Sagittarius. Photographs of the two clouds made by Russell in 1890 show that both are spiral in their general structure. In this respect they recall the enormous spiral nebula (invisible to the eye) which envelops the constellation Orion.

XV

THE MILKY WAY

THE true "river of the sky" is the Galaxy, or Milky Way. Even the most brilliant stars have not affected the imagination of mankind as has this mysterious circle of soft, glowing light surrounding the entire firmament. Its appearance on a clear, moonless night is calculated to impress the most thoughtless observer with a sense of awe and mystery, which becomes wonder at the illimitable extension of the universe when we reflect that this path round its borders consists of hundreds of millions of stars.

The first scientific demonstration of the stellar character of the Milky Way was given by Galileo's telescope, but ages before his time philosophers had guessed that the great luminous band was composed of stars. Pythagoras thought that it consisted of distant stars, and Democritus was of the same opinion. Aristotle followed their ideas in this, but imagined that the Milky Way was the birthplace of comets. This conception of the stellar nature of the Milky Way even found its way into poetry centuries before Galileo. Yet, until his time, nobody knew for certain what was the composition of the Galaxy.

Galileo's description of the appearance of the Milky Way in his little telescope is interesting:

> The next object which I have observed is the essence, or substance, of the Milky Way. By the aid of a telescope any one may behold this in a manner which so distinctly appeals to the senses that all the disputes which have tormented philosophers through so many ages are exploded at once by the irrefragable evidence of our eyes, and we are freed from wordy disputes upon this subject, for the Galaxy is nothing else but a mass of innumerable stars planted together in clusters. Upon whatever part of it you direct the telescope, straightway a vast crowd of stars presents itself to view. Many of them are tolerably large and extremely bright, but the number of small ones is quite beyond determination.

As soon as one begins to observe the Milky Way with the least care, it becomes evident that it varies immensely in brilliancy in different places, and that its borders are very irregular, although upon the whole it pursues a fairly straight course inclined at an average angle of about twenty-five degrees to the axis of the equator. Owing to this inclination, the Milky Way lies in a long band along the northern horizon in the evenings of May, stretching from the western to the eastern points, while in October, November, and December it crosses the sky between the zenith and the north pole like a vast arch. In the latter part of January this luminous arch springs from the horizon in the southeast, passes through the zenith, and reaches the horizon again in the north-northwest. In the middle of March it runs parallel with the meridian on the west, and at the end of

July it occupies a similar position east of the meridian. It is at this time that its most conspicuous reaches, running from Cassiopeia through Cygnus and Aquila to Sagittarius and Scorpio, are best seen. The half of the Milky Way that lies south of the equator is, upon the whole, the most brilliant.

The immense amount of detail that the Milky Way presents, and the striking variations in its appearance at different points along its course, make it well worth while to trace it throughout its whole extent. In fact, it is necessary to do so if we would form an idea of the "architecture of the heavens," for the Milky Way enters as the foundation and frame of the entire structure. It indicates not only the general shape, but the skeletal details of the vast organic whole which we call the universe. Sir William Herschel's original idea was that the Milky Way showed that the stellar system was shaped like a disk, the sun being somewhere near the centre, so that when we look out in the direction of the plane of the disk we see innumerable stars, while when we look at right angles to that plane our vision ranges out into the open space on either side, where but few stars are to be seen. It was with this idea in mind that he devised his method of star gauging, reaching deeper and deeper into space with his telescopic plummets as the size and power of his instruments increased. Later he modified his views, and approached more to the modern idea, that the stars are not distributed uniformly inside the circuit of the Milky Way, but that the latter is, in reality, what it looks to be, a vast ring or spiral of distant stars surrounding the entire sys-

tem, and enclosing a relatively empty space. Through this relatively empty space our sun, with its attendant planets, is journeying. If its course has always been a straight one, and if it is to continue the same in the future, then it must once have been near the edge of the Milky Way in the south, and eventually it will approach the opposite edge of the Milky Way in the north.

The idea that the Milky Way is a ring of stars, made up of subsidiary spirals, is borne out by the varied aspects which it presents at different points along its course. I cannot too strongly urge, even upon the naked-eye observer, the utility and the charm of studying the Milky Way in detail. No more delightful occupation can be imagined for a summer's night, when the moon is absent, when the heavens are clear and serene, and when the observer finds himself at a distance from the smoke and blaze of towns and cities. It is useless to try to see the Milky Way where the atmosphere is impure and the air filled with the diffused light of electric lamps. It is one of Nature's phenomena which she exhibits in full glory only to those who love to be alone with her.

There is a line of constellations which may be called the Milky Way constellations, since they are all to a greater or less extent involved in it. Beginning near the north pole, and following the order of right ascension, these constellations are: Cassiopeia, Perseus, Auriga, Gemini (the feet), Orion (the club), Monoceros, Canis Major (the head), Argo Navis, the Southern Cross, Centaurus (the feet), Ara, Scorpio (the tail), Sagittarius, Scutum Sobieskii, Aquila, Cyg-

nus, and Cepheus, which brings us back again to the neighborhood of the north pole.

In Cassiopeia, where its width varies from five to ten degrees, the Galaxy passes through the body and chair of the imaginary figure, and is, in general, of the second order of brightness, according to Heis's estimate. But the brightness varies in different spots, and faint branches extend in various directions, one running nearly to Polaris. In leaving Cassiopeia the stream narrows and loses brilliancy, but brightens again after entering Perseus, and is very brilliant around the wonderful double-cluster in the "Sword-hand." There are many offshoots here interspersed with dark spaces. One of these involves Algol, and passes far beyond; another, still larger, passes the Triangle and reaches the head of Aries.

Nearly the whole constellation of Auriga is involved in winding branches of the Milky Way. The brightest portions are between Capella and El Nath in the northern horn of Taurus. One vast loop is thrown out to the Pleiades, although its course is not brilliant; another, similar, reaches and surrounds the Hyades.

Passing between Gemini and Orion, the stream with its side-currents becomes very broad, although faint in many places. It is bright around the feet of Gemini, and a curtain of faint light spreads almost to the heads of the Twins, Castor and Pollux, lying near its edge. A vast extension, but one not readily seen except in a very clear sky, involves the belt of Orion. Otto Baeddicker, who, at Lord Rosse's observatory in Ireland, has made very elaborate studies

of the Milky Way, represents a most singular bend setting off from the main stream between Taurus and Orion, and running in a long, narrow curve through the rows of stars that form the "lion's hide," which Orion is represented as carrying for a shield on his left arm. The genesis of all this part of the heavens is evidently recent. It is full of a peculiar type of stars, called the Orion stars, in a relatively early stage of development; it is marked by some of the most singular offsets from the Milky Way, apparently associated with notable rows of stars; and it contains the most unique nebulous objects, connected with groups and clusters of stars, like the nebulæ in the Pleiades and around Orion's belt. One might call it the New World of space, where the more ancient parts of the starry universe may see their history re-beginning and developing on a grander plan, with more magnificent details.

In Monoceros and Canis Major the Milky Way is faint; in Argo Navis it spreads into broad shallows, but on approaching the Southern Cross it suddenly narrows to a lune-shaped strait, which immediately afterwards expands into a vast luminous cloud completely enveloping the lower part of the Cross and extending on into Centaurus. Between the Cross and Alpha and Beta Centauri appears, in the very midst of the brightest part of the stream, a phenomenon which drew almost as much attention from the early navigators of the South Seas as the Cross itself, and which Mr. J. Ellard Gore says is considered by some observers to be the most extraordinary feature of the southern sky. This is a black, pear-

shaped spot about eight degrees long by five degrees wide, bearing the name of the Coal Sack. Some of the first explorers of the southern hemisphere seem to have thought that it was a real object among the stars, and this was the opinion of the sailors, who looked upon it with more or less awe. It is, in fact, an opening in the Milky Way, containing but one star visible to the naked eye, and that a very faint one, while its borders are sharply defined by rich banks of stars. The telescope shows other faint stars within the opening, but they are too scattered to make any impression on the eye, so that the effect of contrast causes the Coal Sack to appear distinctly blacker than any other part of the sky.

After passing Centaurus the Milky Way splits in two, the larger and brighter stream passing through Ara into Sagittarius, while the other enters the eastern end of Scorpio and finally fades away in Ophiuchus after throwing out one or two cross-streams which connect it with the main current in Sagittarius. This portion of the Milky Way, which lies just above the southern horizon, as seen from our middle latitudes in summer, is very striking in appearance. On a dark night it suggests vast sheets of heat lightning arrested and motionless. But brilliant as this part of the Milky Way appears to us, it is far more brilliant when seen from tropical latitudes on either side of the equator. A vivid description of its appearance in the dry air of the uplands of South Africa is quoted by Mr. Gore from Colonel Markwick, an English army officer:

Certainly the Milky Way about the neighborhood of Lupus, Ara, and Norma is a wonderful spectacle, full of a mysterious weirdness with its delicate cloud-like wisps of light and dark passages twining in and out among the star mist. To my mind there is no part of the northern Milky Way to compare to this.

In Sagittarius and Scutum Sobieskii there are spots which look like luminous knots to the naked eye. The stream is also very bright in Aquila, and wonderfully so in Cygnus, where its long, winding reaches and cross-currents involve the entire figure of the Northern Cross. From Cygnus it passes into Cassiopeia, the point from which we began.

One cannot study the Milky Way without observing that the great majority of the first-magnitude stars are arranged in, or close along, its course. These are Sirius, Canopus, Alpha Crucis, Alpha and Beta Centauri, Antares, Altair, Vega, Capella, Aldebaran, Betelgeuse, Procyon, and Rigel. The only first-magnitude stars which are situated at a great distance from the Milky Way are Arcturus, Regulus, Spica, Achernar, and Fomalhaut. Stars of lesser magnitude also increase in number as the Milky Way is approached, and a very notable circumstance is that the curving wisps and rays that set off from the Milky Way are almost invariably accompanied by accordant curves of stars.

The great circle of first-magnitude stars—with, of course, many of the second magnitude among them—to which attention has just been called, has often been the subject of remark, and Sir John Herschel and Dr. Gould thought that it indicated the existence of

a flat, disk-shaped cluster of comparatively near-by stars, to which our own sun belongs, placed within the ring of the Milky Way with its plane inclined to the latter at an angle of about twenty degrees.

The distance of the Milky Way is appalling. Only most uncertain estimates can be made of it, but there seems to be no question that it must exceed twenty thousand millions of millions of miles. Light would require between three and four thousand years to dart over such a distance. If the solar system is travelling from one side of the Milky Way to the other, across the central opening, the whole journey will consume about fifty millions of years.

The mythology of the Milky Way extends through the literature of all nations. Naturally it has always been regarded as a road or path, and the most beautiful legends have been associated with it. All of the early nations connected it with the abode of their gods and of translated spirits. It was the pathway of the supernal powers, or that pursued by the dead on their way to brighter realms. The North American Indians, with a delicacy of imagination not inferior to that of the Greeks, saw in the string of brilliant stars that follows the line of the Galaxy the camp-fires lighted along the pathway of the spirits on their journey to the Happy Hunting Grounds. The Greeks, the Hindoos, the Chaldeans, the Egyptians, the Norsemen, the savage tribes of Africa and of Australia, all regarded it as a celestial pathway.

One of the Greek legends connected it with the story of Phaeton and his unfortunate adventure with the Chariot of the Sun, when the horses, taking fright

at the spectacle of the monsters of the zodiac, and feeling no longer the hand of Apollo upon the reins, bolted from their road, set the heavens on fire, and came near burning up the earth. The scorched track of their runaway was marked by the Milky Way. Another story said that the gods trod this way. In ancient England the Milky Way was sometimes called Watling Street, leading to Asgard; also the Asgard Bridge, a name likewise given to the rainbow.

Often, however, the idea of a river was associated with the Milky Way, and it must be said that this is more in accord with its appearance. The Chinese and the Japanese regarded it as a stream, and had a beautiful legend that the silvery fishes sporting in its waves were frightened and hid themselves at the sight of the new moon, the shape of which suggested a hook —a very good way of accounting for the fact that the star-clouds of the Galaxy almost disappear in the presence of moonlight. The Greeks also sometimes called it the Ocean Stream.

But returning to the idea of a pathway, the Bushmen of South Africa, like the American Indians, associated it with the thought of lights illuminated in the night to guide wandering spirits. It was a line of glowing ashes and embers, they said, by which benighted travellers might find their way. Other savage tribes regarded it as a road along which their dead friends were hunting ostriches. Mr. Allen ascribes this belief to the Patagonians.

Lafcadio Hearn, writing of the romance of the Milky Way among the Japanese, and particularly of the story which we have already referred to in con-

nection with the constellations of Aquila and Lyra (Chapter IX), says, in his eloquent way:

In the silence of transparent nights, before the rising of the moon, the charm of the ancient tale sometimes descends upon me out of the scintillant sky, to make me forget the monstrous facts of science and the stupendous horror of Space. Then I no longer behold the Milky Way as that awful Ring of the Cosmos, whose hundred million suns are powerless to lighten the Abyss, but as the very Amanogawa itself—the River Celestial. I see the thrill of its shining stream, the mists that hover along its verge, and the water-grasses that bend in the winds of autumn. White Orihimé I see at her starry loom, and the Ox that grazes on the farther shore—and I know that the falling dew is the spray of the Herdsman's oar.

XVI

THE ZODIACAL LIGHT

THIS mysterious phenomenon is not, strictly speaking, a stellar object, although it is unquestionaably connected with a star—our own sun. Like the constellations and the Milky Way, it has long attracted a great deal of attention, although it is too indefinite to have any mythological associations, and even yet its nature is not well understood. The general opinion at present is that the Zodiacal Light is a faint extension of the sun's corona. It is generally described as a cone-shaped or lenticular light, rising above the western horizon after sunset and above the eastern horizon before sunrise, but not to be seen at all seasons. It is especially a naked-eye object, for it is too diffuse to be observed with a telescope, and attempts to photograph it are not very successful.

The light lies in, or very near, the plane of the ecliptic, and consequently is best seen when the ecliptic makes the steepest angle with the horizon. For our latitudes this occurs in the evening during February, March, and April, and in the morning during September and October. It can be traced in a clear sky, and in the absence of moonlight to a distance of about sixty degrees from the sun. Of course, it cannot be

seen while the sun is above the horizon, and not immediately after sunset or before sunrise. It is sometimes confounded with twilight, but its distinct nature may be immediately recognized from its shape. Naturally it is best seen in equatorial regions, and Lieutenant Jones, who made a special study of it many years ago, traced it past the zenith, and believed that he could follow it completely across the sky. It ought, indeed, to be thus visible, under favorable circumstances, if it be what it is supposed to be—a nebulous envelope surrounding the equatorial part of the sun, and extending beyond the orbit of the earth. But there is great uncertainty concerning the light seen in that part of the sky opposite to the sun, and many observers think it is not a portion of the true Zodiacal Light. This light, opposite the sun, is known as the Gegenschein, and has been particularly studied by Barnard. It is extremely faint, and few have ever seen it.

I have already, in Chapter I., referred to a view of the Zodiacal Light which I once had in an early autumn morning from the bare cone of Mount Etna, when it shone with a brilliancy that greatly surprised me. M. Du Chaillu has given a picturesque description of its appearance as he saw it during his gorilla hunts in Equatorial Africa:

> As if to give a still grander view to the almost enchanting scene, the Zodiacal Light rose after the sun had set, increasing in brilliancy, of a bright yellow color, and rising in a pyramidal shape high in the sky, often so bright that it overshadowed the brightness of the Milky Way and the rays of the moon, the beautiful yellow light diminishing towards

the apex. It cast a gentle radiance on the clouds around it, and sometimes formed almost a ring, but never perfect, having a break near the meridian; at times being reflected in the east with nearly as much brilliancy, if not as much as in the west, and making one almost imagine a second sunrise.

The Zodiacal Light in its brightest part is more brilliant than the Milky Way. It is brightest along its central line, and gradually fades away at the sides. It has at times been supposed to be variable in brilliancy. Humboldt says that in Europe several successive years elapsed during which it was affirmed that scarcely any Zodiacal Light could be seen. He this describes his observations of it during a voyage from Lima to the western coast of Mexico:

For three or four nights, between 10° and 14° north latitude, the Zodiacal Light has appeared in greater splendor than I have ever observed it. An hour after sunset it was seen in great brilliancy between Aldebaran and the Pleiades. Narrow, elongated clouds are scattered over the beautiful deep azure of the distant horizon, flitting past the Zodiacal Light as before a golden curtain.

These observations were made about the middle of March.

Professor Wright, of Yale, has found that the spectrum of the Zodiacal Light is continuous, indicating that it is simply reflected sunlight, and Professor Young apparently favored the view that the phenomenon was caused by the existence of myriads of small meteoric bodies revolving around the sun nearly in the plane of the ecliptic, and "forming a thin, flat sheet like one of Saturn's rings, and extending far

beyond the orbit of the earth." This recalls a remark of the Russian astronomer Struve, that, in all probability, Saturn's rings viewed from that planet itself would not look as they do to us, but would appear only as a shimmering wreath surrounding the planet, and perhaps no brighter than the Milky Way. Sir John Herschel, who entertained a similar idea of the nature of the Zodiacal Light, suggested that the presence of this phenomenon might give the sun, as viewed from distant space, the appearance of a nebulous star. He also expressed the opinion that the Zodiacal Light might be "no other than the denser part of that medium which, we have some reason to believe, resists the motion of comets; loaded perhaps with the actual materials of the tails of millions of those bodies of which they have been stripped in their successive perihelion passages."

But the whole subject is still involved in obscurity, and a generally acceptable theory of the origin and nature of the Zodiacal Light remains to be found.

XVII

THE PLANETS

THE distinction between the stars and the planets as they appear in the sky is one which is never popularly made. For all except astronomers and persons accustomed to view the heavens, the planets are simply stars. There is an unquestionable difference to a trained eye between the light of a planet and that of a star, the first being steadier and less affected by the phenomenon known as scintillation, but to most eyes this difference is not readily apparent, although everybody recognizes it when once it has been pointed out. The fact is the stars are so distant that, notwithstanding their immense actual magnitude, they appear, even with the telescope, as mere points, while the planets are near enough to present sensible disks. Moreover, the stars shine with a piercing light of their own, while the planets are luminous only with reflected sunlight.

Nevertheless, a very large planet, like Jupiter, or one of moderate size, like Venus, which comes relatively near to us, outshines even the most brilliant of the stars. Venus has often been distinctly seen in the daytime with the naked eye, and its light is at times sufficiently bright to cast a shadow. Even Mercury

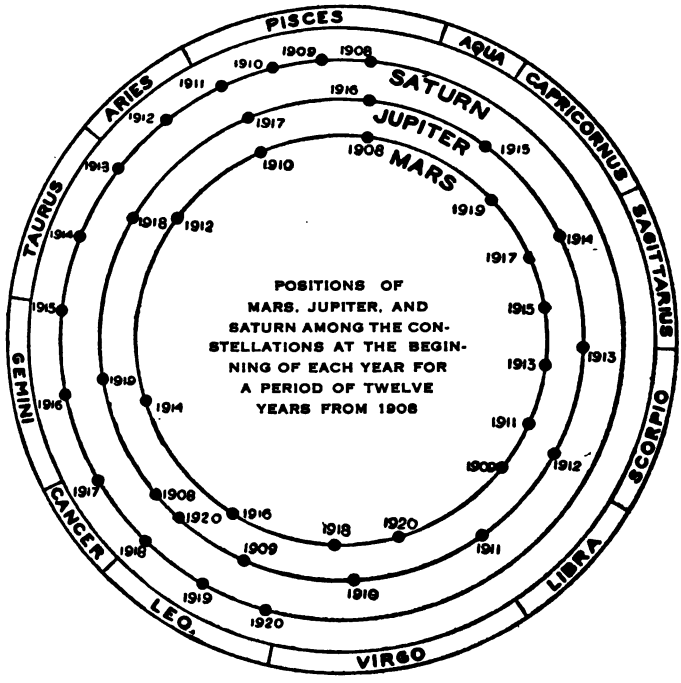
and Mars, except when the latter is in the more distant parts of its orbit, are brighter than standard stars of the first magnitude, and Mars in opposition, with its startlingly red light, overpowers the most brilliant stars that lie along its path.

For the ordinary observer of the heavens the ceaseless changes of place which the planets undergo make their identification more or less difficult. Since, like the earth, they all travel regularly around the sun, it is manifest that they must appear continually in motion against the background of the starry sky, which is spread like a spangled curtain behind them. The rapidity of their changes depends upon their distance from the sun. The nearer ones, travelling at a higher speed and having shorter orbits, go round in a relatively brief time, while the more distant ones, moving more slowly and having much larger orbits, require long periods to complete their circuits. Two of the planets, Mercury and Venus, being nearer the sun than the earth is, never appear to us at a point in the sky opposite to the sun, but are always seen on one side or the other of it—sometimes on the east side after sunset, and sometimes on the west side before sunrise. They are the true Morning and Evening stars. The other planets, being all more distant than the earth from the sun, may be seen in any part of the sky along the zodiacal circle at any hour of the night, their visibility at any particular time depending upon their positions in their orbits, and also upon the position of the earth with reference to the sun. They may be behind the sun as viewed from the earth, or they may be in the quarter of the sky opposite to the sun.

But the apparent perplexity involved in the effort to follow the planets through the sky, which seems hopeless to those who have never undertaken to solve the problem for themselves, disappears as soon as they have once been recognized, and their places at any given time have been ascertained. After that, from a knowledge of their orbital movements, they can be found at any subsequent time.

We shall concern ourselves here with only five of the planets—Mercury, Venus, Mars, Jupiter, and Saturn—because the other two, Uranus and Neptune, are too faint on account of distance to be studied with the naked eye. A diagram has been made to aid the reader in tracing the places of the three outer planets named. In this diagram the positions of the twelve zodiacal constellations are shown, and within the circle of the constellations three other circles are drawn—one for Saturn, one for Jupiter, and one for Mars; and on these circles the positions of the respective planets are marked in twelve successive years, from 1908 to 1920, covering a complete revolution of Jupiter. Simply for convenience of reference, the positions are shown at the opening of each year. For Jupiter, and more especially for Saturn, these positions change very little in the course of a few months, but Mars travels much more swiftly. By noting in what constellation the planet appears, as shown in the outer circle, its approximate place among the stars may be ascertained. When once it is known that Jupiter, Saturn, or Mars is to be seen within the borders of any given constellation, no difficulty will be found in recognizing the planet concerned, especially after the reader has be-

come a little familiar with the grouping of the stars in each constellation, for then the presence of a large planet among the well-known stars proclaims itself.



The recognition of the planets is rendered so much the easier by the fact that their orbits are all confined within the limits of the zodiacal band, which extends eight degrees on each side of the ecliptic, or the apparent path of the sun. Accordingly they are always to be found in one or another of the zodiacal

constellations. They all advance from west to east, although when they are nearest to the earth they appear for a relatively short time to move slowly backward, an effect of the more rapid motion of the earth in passing them.

It will be found that the position of a planet at the beginning of any particular year may be so close to the sun that the planet cannot readily be seen at that time, for the sun makes the round of the zodiac once every year, passing each of the planets in succession. The reader may allow for this, and may estimate when the planet will be far enough from the sun to be visible by simply noting that in January the sun passes from Sagittarius into Capricornus, in February from Capricornus through Aquarius, in March from Aquarius through Pisces, in April from Pisces through Aries, in May through Taurus, in June from Taurus into Gemini, in July from Gemini through Cancer, in August from Cancer through Leo, in September from Leo into Virgo, in October through Virgo into Libra, in November through Libra into Scorpio, and in December from Scorpio into Sagittarius.

The constellations, as before explained, have, in consequence of the precession of the equinoxes, drifted out of connection with the framework of the zodiac which is formed with the *signs* as a basis. Thus the *sign* Aries is now in the *constellation* Pisces, the *sign* Taurus covers the *constellation* Aries, etc. In the almanacs the course of the sun and planets it traced by the zodiacal signs, but since it is the constellations and not the signs which are visible in the sky, I have used the constellations for reference in indicating the

places of the planets. The chief disadvantage arises from the fact that while the *signs* are all exactly thirty degrees in length, the constellations are of various lengths, and have more or less arbitrary boundaries. Yet their distinguishing star groups render them always recognizable, and so they may serve for sign-posts in naked-eye observation to indicate the movements of the planets.

For the two inner planets, Mercury and Venus, no diagram covering any considerable period of time is practicable. But many almanacs show when they are to be seen as morning and evening stars, and those who wish to trace their apparitions in advance may do so with the aid of the "Barritt-Serviss Star and Planet Finder." The period of Mercury from one conjunction to the next is about one hundred and sixteen days, and that of Venus is about five hundred and eighty-four days.

To the ancients, watching the constant movements of the planets, as well as of the sun and the moon, these movements being superposed upon the apparent annual revolution of the entire heavens, the celestial system appeared extremely complex, and hence arose the old Ptolemaic theory that the earth was the common centre of the whole, while the periodic backward movements of the planets were produced by motion in epicycles. But ages before Ptolemy the geocentric idea had prevailed, and upon it was based the poetically beautiful conception of the Music of the Spheres. Each planet, including the sun and the moon, was supposed to be carried in a transparent crystalline sphere, and the motion of

these spheres rotating one within another was conceived to give rise to a celestial harmony audible to the gods, but beyond the range of human ears:

> There's not the smallest orb which thou behold'st
> But in his motion like an angel sings,
> Still quiring to the young-eyed cherubims.
> Such harmony is in immortal souls,
> But whilst this muddy vesture of decay
> Doth grossly close in it we cannot hear it.
> —*Merchant of Venice, Act V., Scene 1.*

An elaborate scale of harmony was invented representing the tones of the various spheres. Cicero was delighted with these old Greek ideas, and gave them elegant expression. He thought that the moon should be regarded as the bass singer in this heavenly choir, while the fixed stars furnished the higher notes. Kepler, who spent as much time in such dreams as in scientific study of the universe, gave the bass notes to Jupiter and Saturn, the tenor to Mars, the contralto to the Earth and Venus, and the soprano to Mercury.

Mercury

The five naked-eye planets were naturally the only ones known to the ancients, and of these Mercury, the nearest to the sun, was probably the last to be recognized. The time of his first discovery is unknown, but there is extant an observation of him made sixty years after the death of Alexander the Great, and a Chinese observation in the year 118 B.C. He must have been seen at a much earlier date, alter-

nately in the morning and the evening sky. At first he was supposed to be two independent planets, and accordingly received two names. As a morning star the Egyptians called him Set, and as an evening star Horus. The corresponding names among the Hindoos were Buddha and Rauhineya, and among the Greeks Apollo and Mercury. Finally the fact was recognized that the supposed two planets were really one, and the name Mercury was universally bestowed upon it in the Greco-Roman world. This name afterwards became associated with our fourth day of the week, which appears as Wednesday in English, derived through the Saxon *Wuotan*, but which was *Mercurii dies* in Latin, whence the French Mercredi.

Mercury (Ερμης in Greek) was the messenger of the gods, and himself a god, who especially patronized orators, merchants, travellers, and thieves. He was the first of thieves, a very Olympian Tweed, for he feared nobody when the itch for possession seized him. He stole Jove's sceptre, Mars's sword, Neptune's trident, and Venus's girdle. He could assume any shape, and nobody could trust him; and yet the gods loved him. He was the personification of shrewdness. If myth-making were in fashion now there would be no difficulty in finding a prototype for Mercury.

Astronomers have to acknowledge that their science was born as astrology, and the astrologers based their system of celestial influences mainly upon the planets (including the sun and the moon). They adopted the ancient ideas about the character of Mercury. Says old William Lilly:

We may not call him either masculine or feminine, for he is either one or the other as joined to any planet, for if in conjunction with a masculine planet he becomes masculine, if with a feminine then feminine; but of his own nature he is cold and dry, and therefore melancholy. With the good he is good, with the evil planets ill. He is author of subtlety, tricks, devices, perjury. Being well dignified, he represents a man of a subtle and political brain and intellect, an excellent disputant and logician, using much eloquence in his speech . . . a searcher into all kinds of mysteries and learning, sharp and witty, naturally desirous to travel, a man of unwearied fancy, curious in the search for any occult knowledge, able by his own genius to produce wonders, given to divination. If he turn merchant no man exceeds him in way of trade or invention of new ways whereby to obtain wealth. . . . If ill-dignified he is a troublesome wit, a kind of phrenetic man, his tongue and pen against every man, a great liar, boaster, tattler, busybody, a tale-carrier, addicted to wicked acts, easy of belief, an ass or very idiot, constant in no place or opinion, cheating and thieving everywhere. If he prove a divine, then a mere verbal fellow, frothy, of no judgment, easily perverted. . . . He generally signifies all literary men, philosophers, mathematicians, astrologians, merchants, sculptors, poets, orators, advocates, schoolmasters, ambassadors, artificers; sometimes thieves, grammarians, tailors, usurers.

Perhaps the most curious thing in connection with this is that astrology still survives, and I do not know how many thousands of men and women yet think, or allow themselves to be persuaded, that if Mercury presided over their birth they must partake of these qualities, according as his protean nature may have been affected at the time by the influence of other planets. These things, however ridiculous they may be, have played far too great a part in human history to be ignored. Even Kepler was af-

fected by astrological superstition, and Tycho cast horoscopes when royalty commanded and he couldn't refuse. Galileo, to banish the fears of the wife of the Grand-Duke Ferdinando I., who was very ill, recast his horoscope, and predicted that he had yet many years to live. But, alas! for Galileo's skill in astrology, Ferdinando died within twenty-two weeks.

As a naked-eye object Mercury is very brilliant when he can be seen, which is not very frequently. He never gets more than about twenty-eight degrees from the sun—less than the length of one zodiacal sign. As a morning star he is best seen, from our latitudes, in the autumn, and as an evening star in the spring. At his greatest elongation he never sets or rises much more than two hours after, or before, the sun. It is a legend in astronomical history that Copernicus never succeeded in seeing Mercury. Mr. Hind, the distinguished English astronomer, never saw Mercury with the naked eye but once in his life. On account of his shy habits he excites curiosity, and it is very well worth anybody's while to get a glimpse of him when he is well placed. He glows in the twilight with great brilliancy, although far inferior in brightness to Venus when she is near. Occasionally the two planets may be seen in conjunction, in the morning or evening sky, and the spectacle is always an interesting one. The light of Venus is whiter and more dazzling, probably owing to the dense clouds in her atmosphere. Mercury sometimes presents a slightly reddish tint. Owing to his rapid movements, he soon disappears in the sun's rays, only to emerge again a few weeks later on the other side. Perhaps the sur-

prise experienced by the eye in seeing Mercury so bright in the retreating or the on-coming daylight adds to the effect that he produces. To the eye of fancy he resembles a gem pinned upon the curtain of the evening, and the Greeks often spoke of Mercury by the name of The Sparkler.

Mercury has given his name to a metal which, in some respects, is not unlike the planet, being very sparkling in appearance and very shifty in conduct, running away and hiding itself whenever the chance offers. The old alchemists originally bestowed the name of Mercury upon all volatile metals, but since their time it has been restricted to "quicksilver," a word derived from the Latin *argentum vivum*. It is a singular fact that, according to recent determinations, the density of the planet is about equal to that of the metal mercury.

The ancient idea that Mercury was the patron of travellers may have been suggested by the rapid movements of the planet. Being, in round numbers, only 36,000,000 miles from the sun, his mean orbital velocity amounts to twenty-nine miles per second, while when he is travelling at his highest speed he goes thirty-five miles per second. The difference in his velocity at different times arises from the great eccentricity of his orbit. When in perihelion he is only 28,500,000 miles from the sun, while at aphelion this is increased to 43,500,000. In other words, his distance from the sun varies to the extent of 15,000,000 miles, and this in a period of only about six weeks! On the average he receives from the sun nearly six and three-quarters times as much heat and light as

the earth does, but this amount is so variable that it is more than twice as great in perihelion as in aphelion.

Mercury's period of revolution, or his year, is three-quarters of an hour less than eighty-eight days, and he comes into conjunction with the earth once in about one hundred and sixteen days. From the earth his distance varies from about 57,000,000 miles at inferior conjunction to about 129,000,000 miles at superior conjunction. If the orbit of Mercury lay in the same plane as that of the earth, he would be seen crossing the disk of the sun as a round black spot three times every year—*i. e.*, every time he is in inferior conjunction with the earth. But his orbit is, in fact, so inclined to that of our globe that these transits across the sun are relatively rare. On the average, there are thirteen of them every one hundred years, and they always occur either in May or November. The latest transit of Mercury occurred in November, 1907, and the next four will occur November, 6, 1914; May 7, 1924; November 8, 1927; and May 10, 1937.

Mercury is the smallest of the planets, the asteroids being left out of consideration. His diameter is only three thousand miles, so that his surface is but one-seventh as great as that of the earth. Nevertheless, as already remarked, his density is very great, amounting, according to the estimates of Backlund, to nearly 12.5, that of water being seven. This is nearly the density of the metal mercury. This extraordinary density may be regarded as an indication that the planet is entirely metallic in its constitution. Esti-

mates of the density vary widely, but they are all high. Being situated so near the centre of the solar system, there are reasons why Mercury might naturally be composed of materials of greater mean density than those found in the earth. The heaviest substances would, in the process of condensation from a nebulous state, seek the centre. Being nearer than the earth to the sun, Mercury presents in succession all the phases which are shown by the moon, but these can only be seen with the aid of telescopes.

The question of the presence or absence of life always arises in connection with the planets, and it can only be answered in a general way by appealing to our knowledge of their physical condition, as well as of their situation with respect to the sun, which is the universal source of light, heat, and radiant energy of all kinds. For such information we are partly dependent upon telescopic observation. This is difficult on account of the planet's nearness to the sun, and in recent times many such observations have been made in full daylight when Mercury is high above the obscuring mists and confusing atmospheric currents of the horizon. The results are not very encouraging. Few of the surface features of the planet can be clearly discerned. There is nothing to indicate the presence of oceans and continents, although some observers have thought that they found evidence of the existence of extremely lofty mountains. The general impression at present is that Mercury's surface is altogether barren as far as life is concerned, and that it more nearly resembles the moon than the earth.

Schiaparelli, Lowell, and other observers believe that they have found permanent markings upon Mercury of an unknown character (Lowell's drawings show many of them in the form of narrow lines crossing one another like the "canals" of Mars), and upon observation of these markings has been based the startling conclusion that Mercury does not revolve rapidly upon his axis, like the earth, as all the older observers supposed, but turns only once in the course of a revolution around the sun. The result, of course, is that the little planet lies in a predicament with regard to the sun, precisely like that of the moon with regard to the earth. He keeps always the same face towards the sun, from which it follows that one half is exposed to perpetual day, while the other half is plunged in unending night. The effect upon any forms of life existing on his surface may be left for the imagination to trace. Owing, however, to the great eccentricity of his orbit, there must be a zone, perpendicular to the equator and reaching from pole to pole, over which the sun appears to rise and set once in the course of a revolution. This zone is about fourteen hundred miles in breadth at the equator, diminishing to zero at the poles. But the existence of this zone does not help much in favoring the hypothesis of the possible presence of organic life.

The cause of the coincidence in the rotation and revolution periods is believed to be "tidal friction," a subject mathematically developed by Professor George Darwin, and summed up by him in his book on *The Tides*.

Another thing inimical to life on Mercury is his

nearness to the sun. We have already seen that, on the average, he gets nearly six and three-quarter times as much solar light and heat as comes to the earth. This in itself would seem to prohibit the presence of beings resembling ourselves, for it must make the mean temperature of the planet's surface far above that of boiling water, so that no liquid can exist on it. On the other hand, there is little evidence of the existence of any clouds or any watery vapor on Mercury. But the situation is made still more difficult by the fact of the great and rapid changes of temperature which Mercury undergoes on account of the eccentricity of the orbit. When he is nearest to the sun he receives two and a quarter times as much light and heat as when he is farthest from the sun, and the change from one position to the other occupies only six weeks. This is to be plunged from the frying-pan into the fire with a vengeance! The only thing in which the surface condition of Mercury approaches close to that of the earth appears to be the force of gravity, which is five-sixths of that on our globe. Accordingly there would not be much difference in the weight of a man on Mercury and on the earth.

Upon the whole, then, it may be said that Mercury cannot be regarded as a habitable globe, and it is exceedingly doubtful if he has ever had any inhabitants. If so, they must have differed very widely from the creatures of the earth. So we must dismiss, with an indulgent smile, the speculations of delightful old Thomas Dick concerning the number of intellectual beings in the solar system, in which he assigned just 8,960,000,000 inhabitants to the planet Mercury!

Venus

Gem of the crimson-colored even,
Companion of retiring day,
Why at the closing gates of heaven,
Beloved star, dost thou delay?

—*Campbell.*

The zenith of poetic suggestion and association among celestial objects is unquestionably occupied by the planet Venus. The singers of all ages and all peoples have chanted her praises, and almost universally she has been associated with the goddess of love:

Étoile qui descend sur la verte colline,
Triste larme d'argent du manteau de la nuit,
Toi que regarde au loin le pâtre qui chemine
Tandis que, pas à pas, son long troupeau le suit,
Étoile! où t'en vas-tu dans cette nuit immense?
Cherches-tu sur la rive un lit dans les roseaux?
Où t'en vas-tu, si belle à l'heure du silence,
Tomber comme une perle au sein profond des eaux?
Ah! si tu dois mourir, bel astre, et si sa tête
Va dans la vaste mer plonger tes blonds cheveux,
Avant de nous quitter un seul instant arrête:
Étoile d'amour ne descends pas des cieux!

—*Lamartine.*

It is unnecessary to say how Venus got her name. Homer, who has mentioned no other planet, could not omit her. His epithet for Venus is "the Beautiful." Like Mercury, Venus appears in succession as morning and as evening star, and, like Mercury, she was at first supposed to be two stars; and she received two distinct names—Phosphorus in the morning, and

Hesperus in the evening sky. Pythagoras is supposed to have been the first to identify Hesperus with Venus. The earliest recorded observation of Venus was made 686 B.C., but she must have been watched with admiration from the beginning of human history. Some have identified her with Isaiah's "Lucifer, Son of the Morning." The Arabs called her El Zorah, the "Splendor of Heaven." Sirius himself pales to insignificance in comparison with Venus when she is near inferior conjunction with the earth. To many persons unfamiliar with the sky she then appears incredibly brilliant for a star, and since the development of electric lamps she has often been mistaken for an aerial signal sent aloft in the night. Arago relates that in 1797, when Napoleon returned to Paris after his campaigns in Italy, he was astonished to see the crowds around the palace of the Luxembourg fixing their eyes upon the sky. Then he looked up himself and saw Venus gleaming there in full daylight. The people enthusiastically applauded the apparition as *his star*. In fact, it is not difficult to see Venus by day if one knows exactly where to look when she is nearest to the earth, and when her distance is reduced to about 26,000,000 miles. Her light then is about one-thousandth of that received from the full moon, but, being concentrated almost in a point, it impresses the eye with dazzling effulgence.

The reason why Venus, like Mercury, cannot be seen in the midnight sky, but only before or after the sun, in the morning and the evening, has already been sufficiently explained. But while Mercury, on

account of his nearness to the sun, can be observed only with some difficulty, Venus, whose average distance from the sun is 67,000,000 miles, goes far enough away from him, first in the east and then in the west, to become very conspicuous. At her greatest elongation she may appear as far as forty-seven degrees from the sun. She returns to inferior conjunction every 584 days. Her conjunction in 1908 occurs July 6th. With this as a basis her future movements can readily be estimated. Her orbital period, or time of revolution around the sun, is 225 days. That, of course, represents the length of her year.

The astrologers have not been less attentive to Venus than to Mercury, and of course they have recognized her "qualities" in her conventional character as the representative of Aphrodite. I quote again from Lilly:

She is a feminine planet, temperately cold and moist; nocturnal, the lesser fortune, author of mirth and cheerfulness. She signifies, when well dignified, a quiet man, not given to law, quarrel, or wrangling, not vicious, pleasant, neat, and spruce, rather drinking much than gluttonous; often entangled in love matters, zealous in affections, musical, delighting in amusement, easy of belief, not given to labor, or to take any pains; a right virtuous man or woman, often jealous, yet without cause. When ill-dignified, a riotous, expensive person, wholly given to dissipation, lewd, fantastical, a mere skip-jack, of no faith, a mere lazy companion, nothing careful of the things of this life or anything religious. . . . She signifies musicians, gamesters, silkmen, mercers, painters, jewellers, players, lapidaries, embroiderers, choristers, fiddlers; when joined with the moon, ballad-singers, perfumers, seamstresses, engravers, upholsterers, glovers, and such as sell those commodities which adorn

women, either in body, as clothes, or in face, as complexion waters. Her cities are Vienna and Turin.

The old astrologer avers that "a right Venus person is a pretty, complete, handsome man or woman." And another astrologer adds that those who have Venus strong in their nativities invariably have dimples in the cheek or chin. It is comforting to be assured of so agreeable a mark of identification, bestowed by so winning a member of the old Olympic conclave.

From Venus is derived the name of the sixth day of the week, *Veneris dies;* in French, *Vendredi.*

In astronomical history Venus is celebrated for having furnished to Galileo, during his first observation with the telescope in 1610, a crushing refutation of the old Ptolemaic, or geocentric, system. Venus, like Mercury, exhibits phases similar to those of the moon as she moves through her orbit. When she is on the opposite side of the sun from the earth, she appears round like the full moon; when she moves between the sun and the earth, she passes through the various crescent and waning phases. These Galileo discovered with his little telescope. But it was dangerous in his day to upset received opinions, and he kept the discovery to himself for a while, simply confiding to his friend Giulio de' Medici an enigmatic announcement of it, to which he himself later furnished the clew. For reference it may be well to give Galileo's Latin anagram, as he sent it in September, 1610, and his explanation of it, sent in January, 1611:

Hæc immatura, a me, jam frustra, leguntur.—O. Y.

Neglecting the superfluous letters O. Y., this reads in English: "These unripe things are read as yet in vain by me."

The explanation was made by simply transposing the letters of the Latin anagram so that it now reads:

Cynthiæ figuras æmulatur Mater Amorum.

This means in English: "The Mother of Loves imitates the shapes of Cynthia." By the "Mother of Loves," of course, he meant Venus, and by "Cynthia" the moon.

The smallest modern telescope easily shows the phases of Venus, which, at first, were imperfectly revealed by Galileo's instrument.

Like Mercury, also, Venus at certain times passes across the disk of the sun. These transits of Venus are both more rare and more important than those of Mercury. For reasons arising out of the relations between the orbital movements of Venus and the earth, the transits occur in pairs, and always either at the beginning of June or the beginning of December. The two transits constituting a pair occur eight years apart, while the successive pairs are separated by an interval of one hundred and twenty-two years. The latest transits of Venus occurred in December, 1874, and December, 1882. The next pair is due in June, 2004, and June, 2012. The present reader will hardly take an expectant interest in the statement that when in transit Venus can be seen with the naked eye (protected by a dark glass), and that the perfect roundness of her figure and the inky blackness of her silhouette make the spectacle surprisingly attractive.

The transits of Venus have held a high rank among astronomical phenomena on account of the opportunity which they afford to measure the parallax, and hence the distance, of the sun. But since 1882 other and better methods have been developed, so that for our descendants of the twenty-first century these transits will probably possess only such interest as their picturesqueness and their historic importance may lend to them.

There are many circumstances which make Venus particularly interesting from the point of view of the problem of habitability. In the first place, she is very nearly the twin of the earth in size. Her diameter is 7700 miles, and her surface is only 5 per cent. less in area than that of our globe. Her density is somewhat less than the earth's, so that the force of gravity on her surface is about 85 per cent. of terrestrial gravity. Anything that weighs 100 pounds on the earth would weigh 85 pounds if removed to Venus. As far as this influences living beings, we might suppose that they would be perceptibly larger on Venus than on the earth.

In the next place, Venus possesses an abundant atmosphere, charged with watery vapor. Both telescopic and spectroscopic observations prove the correctness of this statement. In fact, the atmosphere of Venus appears to be decidedly more dense than the earth's, or at least more cloudy, and this may possibly be an important agent in ameliorating the climatic condition of the planet. Being so much nearer the sun, she gets about twice as much solar light and heat as we do; but, on the other hand, her

orbit is the most nearly circular of any in the solar system, so that, unlike Mercury, she experiences very slight changes in the amount of radiant energy poured down upon her by the sun. A peculiar composition of the atmosphere, or an unbroken canopy of clouds, may modify the heat and the light to a surprising degree. But even without any modification, it is not certain that the doubling of the solar radiation, as compared with its intensity on the earth, would be prohibitive of life. It might be unbearable to *us*, but agreeable to beings constituted to meet it. We may imagine Venus as the tropics of the solar system, a world of intense heats, brilliant colors, sensuous enjoyments, and luxuriant abundance of life.

One of the evidences of the density and probable cloudiness of Venus's atmosphere is furnished by her brilliancy. She is so dazzling in the telescope that hardly any of her features are discernible. The best observations are those made by daylight, when some of the glare is taken off. Mr. Lowell has made the most elaborate drawings of Venus that we possess, and, as in the case of Mercury, they exhibit in some respects a striking resemblance to telescopic pictures of Mars, consisting largely of narrow lines arranged on a system of intersections. Taken by itself, this might be regarded as a suspicious circumstance suggesting possible deception of the observer's eyes. At any rate, the markings on Venus are indistinct, and astronomers in general are not yet disposed to accept the conclusion based upon them, originally by Schiaparelli, and later by Lowell, that Venus, like Mercury, rotates only once on her axis in the course of one of

her years, thus keeping the same face always sunward. If it should finally turn out that this view is well founded, then, it must be confessed, the theory of the habitability of Venus would be much more difficult to maintain. A world half day and half night, with its absolute contrasts of climate, physical conditions, scenery, and race would offer a marvellous field for the play of the imagination, but sober science would not concern itself greatly about animated existence on such a planetary monstrosity.

Brilliant beyond comparison as Venus appears to us, the earth must be far more brilliant when it shines in the midnight sky of Venus. When Venus appears brightest to our eyes, only about one-quarter of her surface, as seen from the earth, is illuminated by the sun. At the same time, nearly the whole surface of the earth appears illuminated as seen from Venus. A short time afterwards, when Venus becomes lost to us in the solar rays, the earth crosses her meridian at midnight in the form of a full moon, and, as observations of the phases both of the moon and of the interior planets prove, the gain in light reflected from a fully illuminated globe is far greater than that indicated by the increase in the area of the reflecting surface. It has been shown, for instance, that the full moon sends us nine times as much light as the half-moon. When the earth is in its full phase, as seen from Venus, it must be a phenomenon of truly amazing splendor, while the attractiveness of the spectacle is singularly increased by the visibility at the same time of the moon, slowly circling about the earth. If the desire to find a means of com-

municating with the other worlds visible in our sky has seized imaginative minds among us, how much more intense should that desire be among the inhabitants of Venus (if they exist), when they behold this great, round earth magnificently pouring her beams upon their heads! When we gaze with admiration at Venus in her glory, it is a captivating thought that to her we present a spectacle far more glorious still. It is true that the intensity of the sunlight received on the earth is only half as great as on Venus, but that hardly affects the comparison. Consider how brilliant Mars appears in opposition, although he receives only about half as much solar light as comes to the earth.

There is one other circumstance affecting the condition of Venus considered as a habitable globe which should not go unnoticed. Many observations seem to prove that her axis is remarkably upright, nearly perpendicular to the plane of the ecliptic. If this is true, she cannot have the marked succession of seasons, with winter and summer chasing each other to and fro across the equator, from one hemisphere into the other, that occurs on the earth, but her climates must rather be arranged in zones—always summer in the equatorial and tropical belt, a changeless spring temperature in higher latitudes, and unbroken winter in the polar regions.

Mars

The immense literature that has grown up about the planet Mars within the past ten years, and the

acerbity of some of the disputes concerning it, demonstrate the hold that the question of the habitability of other worlds possesses not only upon the popular imagination, but upon the minds of many who are engaged in scientific study of the celestial bodies. But long before it became possible to discuss this question on any other basis than that of pure hypothesis, Mars had attracted universal attention. Never so bright as Venus or Jupiter, his startling color, his frequent returns to a prominent position in the sky, and his enormous changes of brightness have always excited a great deal of interest. When he beams like a red signal-lantern in the midnight heavens, Mars fixes the eye like no other celestial object. There is a kind of insistent assertiveness about his appearance which piques curiosity, and at the same time defies it.

In ancient times Mars received everywhere names based upon his ruddy aspect. The Chinese called him, plainly, the Red Planet; the Hindoos, the Ember; the Hebrews, the Burning One; the Egyptians, the Red Horus; the Greeks, the Fiery. He was also invariably associated with the god of war, whatever the particular name of that deity might be. The name which has clung to the planet is that of the Greek Ares, transformed into the Roman Mars. There is a somewhat uncertain Chinese record of an observation of Mars made about 2441 B.C. With the astrologers Mars has always been a malign planet, the "lesser infortune," author of quarrels and strife. When well dignified, says old Lilly, he makes those born under him invincible in feats of war and courage, lovers of

honor, boastful yet prudent, and, when ill dignified, he turns them into murderers, thieves, prattlers, traitors, and oppressors. Besides soldiers, Mars denotes surgeons, physicians, chemists, thieves, hangmen, smiths, bakers, barbers, cooks, carpenters, tanners. The red stars, such as Antares, were supposed to partake of the nature of Mars, and Lilly's famous prediction of the great fire in London in 1666 was based on the ascendency of one of these Mars-like stars in the horoscope of the city. He was summoned before the House of Commons to explain his prophetic powers, but he left his hearers as ignorant as he found them.

Mars stands for the third day of the week, *Martis dies;* in French, *Mardi.*

Mars is the first planet outside the earth, his mean distance from the sun being 141,500,000 miles. The relative distance of Mars from the earth varies more than that of any other planet. When he is on the opposite side of the sun, this distance amounts, on the average, to 234,000,000 miles, and when he is in opposition to the sun it diminishes to only 47,000,000 miles. But his orbit being eccentric, he may sometimes be as far away as 267,000,000 miles, and as near as 35,500,000 miles. The effect upon his apparent brightness is, of course, very great. His orbital period, or the length of his year, is 687 days. The oppositions of Mars to the sun, which afford the best opportunities for the study of his surface, occur once every 780 days. Those oppositions which happen near the end of August or the beginning of September are the most favorable, because, as they occur in that quarter of the sky where Mars's peri-

helion point is situated, the distance between him and the earth is reduced to the least possible amount. The opposition of 1909 will be one of this kind.

In size Mars ranks between Mercury and the earth. His diameter is 4200 miles, and his surface area about 28 per cent. of the earth's. Gravity on his surface is 38 per cent. of terrestrial gravity. A body weighing 100 pounds on the earth would weigh but 38 pounds if transported to Mars. Very important suppositional consequences have been drawn from this, as we shall see later.

The first thing that seized the attention of telescopic observers of Mars was his white polar caps. These both look and behave exactly as we should expect caps of snow and ice to do. The seasons of Mars are very like those of the earth, except that each is nearly twice as long as ours, and, just as with our globe, the sun shines in succession upon the two poles. The inclination of Mars's axis is 24° 50′, only a trifle greater than that of the earth's axis. Thus the effect of the sun rising upon his poles must, other things being equal, closely resemble its effect in the case of the earth. Moreover, Mars's rotation period is wonderfully close to ours, his day and night together covering twenty-four hours and thirty-seven minutes. Consequently, we should expect the general effect of the alternation of sunshine and darkness on Mars to resemble that upon the earth. His atmosphere, however, is very deficient, and this undoubtedly has important results in the distribution and retention of solar heat. In fact, the atmosphere of Mars does not appear to be more dense than that found on the sum-

mits of our loftiest mountain-peaks, and the spectroscopic evidence touching the presence of watery vapor is unsatisfactory. It has been suggested that a slight excess of carbonic acid in Mars's atmosphere would serve to keep the planet's temperature sufficiently high to enable both plant and animal life to flourish on his surface.

However this may be, the behavior of the polar caps seems to indicate that they are composed of snow and ice alternately frozen and dissolved. They regularly and slowly diminish in extent as summer advances, and sometimes one and then the other nearly disappears, as if the whole winter deposit had been melted away.

Synchronously with this disappearance of the polar caps, the famous "canals," first clearly observed by Schiaparelli in 1879, make their appearance. These objects are far beyond the reach of ordinary telescopes, but they have been studied and drawn by a number of observers, notably Schiaparelli and Lowell, and hundreds of them have been mapped. They cover the whole face of the planet, a few of them even traversing the polar regions. They are perfectly straight, and they meet and cross in scores of places, sometimes as many as a dozen coming together at one point, and almost invariably where two or more of these dusky lines cross a sort of knot is seen, like the knots in a spider's web.

The general telescopic aspect of Mars is that of a spotty globe, the surface being divided between light and dark regions, the former of a reddish or ochrish tint, and the latter having a dusky green or blue

tinge. These were formerly called, respectively, continents and oceans, but at present it is believed that no large bodies of water can exist on Mars. The "canals" traverse these variously colored regions with indifference, although they are much more numerous in the light, or reddish, areas. There is one spot, sometimes called the "Eye of Mars," which bears no little resemblance to the hub of a wheel, conspicuous "canals" radiating from it, with striking regularity, on all sides.

The prevailing theory in regard to these objects (it is only a theory, and is not "scientifically" accepted by astronomers in general) is that of Mr. Percival Lowell, who thinks that they are probably irrigated lands watered by innumerable canals made by the inhabitants of Mars, who, owing to the desiccated state of their planet, are compelled to depend for a supply of water sufficient to keep vegetation alive upon the annual liquidation of the polar snows. The fact that the "canals" begin to appear soon after the polar caps begin to diminish, and grow darker as the caps become smaller, is perhaps the strongest general argument in favor of the view that the "canals" indicate the existence of water which is alternately withdrawn and re-supplied. The visibility of the canals is ascribed not to the water but to the vegetation whose growth it stimulates.

If it were granted that this gigantic irrigation system really exists on Mars, the most insistent question would be: How can any imaginable race of beings have performed such a labor? The reply that has been suggested is based upon the small force of

gravity on Mars. We have already seen that this force is only 38 per cent. of terrestrial gravity. This may work to advantage in two ways. In the first place, animal forms might attain a far greater size upon Mars than upon the earth, with coincidently greater muscular strength, without being oppressed by their own weight. In the second place, since all bodies are relatively light on Mars, mechanical powers could be much more efficiently applied there than here. Thus a race of powerful giants on Mars might be able to achieve public works hopelessly beyond the range of man's capacity on the earth.

That the theory is fascinating no one will deny, but confessedly it lies beyond the limits of positive demonstration, and some astronomers prefer to believe that the "canals" of Mars are some kind of natural phenomena arising from the effects of fracture in the crust of a cooling and contracting globe. That they are not illusions or deceptions of the observer's eye seems to be demonstrated by the fact that during the opposition of Mars in 1907 many of the more conspicuous "canals" were photographed, at least in part, by Mr. Lowell and his assistants.

Mars possesses two minute moons, revolving with great rapidity at a very close range, but, since they lie beyond the reach even of the majority of telescopes, and since they are not important bodies in themselves, they need not long detain our attention. They were first detected by Professor Asaph Hall in 1877, and they were named Deimos and Phobos, or Flight and Fear, which is a return to mythology, Flight and Fear having been the horses that drew the chariot of

the war god of Olympus. Deimos revolves around Mars at a distance of 15,000 miles in 30 hours 10 minutes, and Phobos at a distance of 6000 miles in 7 hours 39 minutes. These distances are from the centre of the planet. Neither of these toy satellites probably exceeds ten miles in diameter.

Jupiter

The ancients reasoned well when they gave the name of the chief of the gods to the planet Jupiter. Although Venus, when at her brightest, far outshines Jupiter, yet there is no planet which can rival him in the unfailing stateliness of his appearance. His slow, majestic movement along the zodiac (he requires twelve years to make the circuit of the sky) adds to his impressiveness. He is by far the largest of all the planets, although those who named him were unaware of that fact. Observations of Jupiter are found in Chinese records several thousand years before our era. The Chinese called him the Regulator, and also the Planet of the Year. Flammarion has suggested that the latter name may have been derived either from the fact that he takes twelve years for a revolution, equal to the number of the months, or from the fact that he is conspicuously visible for a large part of every year. The Egyptians knew him as Horus, the Guider of the Sphere. The Hindoos and the Greeks both regarded Jupiter as the chief of the planets. Astrologically Jupiter was the "Greater Fortune." When well aspected, says Lilly, he is magnanimous, faithful, bashful, aspiring in an hon-

orable way at high matters, a lover of fair dealing, doing glorious actions, honorable and religious, wonderfully indulgent to wife and children, full of charity and godliness, just, wise, prudent, and virtuous. But when Jupiter is afflicted by malign planets, says the astrologer, he wastes his patrimony, is hypocritically religious, obstinate, ignorant, careless, gross, dull, abasing himself. We need not be surprised to hear that he signifies judges, senators, councillors, bishops, priests, cardinals, chancellors—but why woollen-drapers?

The fifth day of the week takes its name from Jupiter, *Jovis dies;* in French, *Jeudi.*

Jupiter's average distance from the sun is 483,000,000 miles, more than five times the distance of the earth. This is variable to the extent of 21,000,000 miles. From the earth his distance varies between 369,000,000 and 576,000,000 miles. On the average, says Professor Young, he is about five times as bright as Sirius. His oppositions to the sun occur once in every 399 days. His colossal globe is 88,000 miles in diameter, measured through the equator, and 83,000 miles measured through the poles, so that the polar flattening is very evident in telescopic views. This has no doubt originated from his swift rotation on his axis, a single turn requiring five minutes less than ten hours. Day and night, accordingly, flit over his surface with astonishing speed, and in a few hours, watching with a telescope, the effect of his rotation becomes very evident.

His four principal moons (three very minute ones have been discovered since 1892) add immensely to

the interest of Jupiter. It has been alleged that these moons can sometimes be seen, under exceptional circumstances, and by eyes of extraordinary power, without optical aid. The discovery of these moons by Galileo, in 1610, made a great sensation. These were Galileo's "Medicean stars," named in honor of the brothers Cosimo, Francesco, Carlo, and Lorenzo de' Medici. Mr. Fahie, in his *Life of Galileo*, gives an amusing instance of the competition which immediately arose among some of the crowned heads of Europe for the honor of having their names put in the sky by the great discoverer. Within about three months after his discovery of the Medicean stars, Galileo received a letter from the French court, saying:

> In case you discover any other fine star, call it by the name of the Great Star of France, as well as the most brilliant of all the earth, and, if it seems fit to you, call it rather by his proper name, Henri, than by the family name Bourbon. Thus you will have an opportunity of doing a thing due and proper in itself, and, at the same time, of rendering yourself and your family rich and powerful forever.

It was the great Henri IV. in whose behalf this application was made; but as the king was assassinated two months later, Galileo had no opportunity to take the bribe, even if he had been disposed to accept it. Needy astronomers in our time have no such chances offered to them of becoming wealthy and powerful, the magnates who now rule the world being less ambitious to shine in the heavens.

For all who possess telescopes the satellites of Jupiter are a ceaseless source of joy. Their move-

ments are so rapid that in the course of a single evening they can be watched crossing his disk, preceded or followed by their round shadows, as distinct as little circles of ink, and can be seen disappearing in his shadow at one edge and reappearing at the opposite edge. Their shifting configurations with each other and with Jupiter are always fascinating to watch.

Dr. Thomas Dick gave Jupiter (in imagination) the enormous allotment of 6,967,520,000,000 inhabitants, verily an appalling "yellow peril" if a "war of the worlds" should ever arise; but Jupiter is certainly innocent of any such over-population, and, indeed, of any population whatever. All careful observations show that this immense globe consists principally, if not entirely, of vapor. Its surface is streaked, parallel to the equator, with broad cloud zones, which change continually in color, shape, and arrangement. It is a most picturesque sight with a telescope, and when looking at it I always recall the vivid description of the appearance of Jupiter in Piazzi Smyth's telescope, which he carried up on the peak of Teneriffie in 1856:

> One could not gaze long without acquiring the impression of looking at a windy sky. The whole zone of vapor seemed to be in motion, while from its ragged edges portions were torn off and were driving along, some of them rolling over and over, and others pulled out in length and rearing up towards the forepart like a sailing boat scudding before a gale. Owing, perhaps, to the effects of perspective, the polar zones appeared quiet and level, and the equatorial band was somewhat more calm, more inclined to strati and cirrostrati than the tempestuous cumulostrati of the tropics.

Piazzi Smyth was unaware of what we now know—that Jupiter's surface has many different rates of rotation, the clouds travelling faster near the equator than towards the poles. Moreover, there is evidence, as Professor Hough has shown, that Jupiter is a many-storied world of clouds, the lower strata travelling at a different rate from those above; and at times the sight seems to range down into depths that may measure a thousand miles.

About the only feature approaching permanence of form on Jupiter is the famous Red Spot, which lies at about thirty-five degrees south latitude, and which has been visible with varying distinctness since 1878. In that year I had the good-fortune to catch sight of it, almost at the earliest-known date of apparition, with a three-inch telescope, the first that I ever owned. At times this spot assumes a deep-red color; at other times it fades away as if covered by a veil; but always its location is indicated by a deep scallop lying exactly alongside of it in the great south equatorial cloud belt. The spot measures not less than 30,000 miles in length, by 7000 in its greatest breadth. It is oval in outline. The cause and nature of this wonderful spot have been much discussed, but the mystery remains unsolved.

Additional evidence of the unsolidified state of Jupiter is furnished by his low mean density. This is only about one-quarter of the earth's density, or, say, one-third greater than the density of water. It is possible, if not probable, that there may be a solid nucleus, but if so it must be intensely heated and incandescent. Owing to his enormous collective mass,

the force of gravity on the visible surface of Jupiter is 2.64 times as great as on the earth. He exceeds the earth 1300 times in volume and 316 times in mass, or weight. About a thousand bodies of the size of Jupiter would make a globe equal to the sun. The probability is that Jupiter only recently, as time is measured in such things, passed out of the condition of a star, or a subsidiary sun, shining with its own radiance, and began to enter upon the earlier stages of planetary condensation. When he shone with his own light he appeared from outer space as a little companion of the sun, the two forming a binary star whose components differed eight or nine magnitudes in brightness.

Saturn

The most distant of the planets known to the ancients received from the Greeks the name Chronos, equivalent to the Latin Saturn. As the name indicates, it was associated with the idea of time, or duration, and no doubt the application to the planet Saturn arose from that planet's exceedingly slow movements. It requires nearly thirty years to make a single circuit of the heavens. Names having a similar meaning were bestowed upon the planet by other early peoples. Saturn's aspect accords with the deliberateness of his movements, and recalls Keats's picture of the dethroned father of the gods in his hidden retreat:

> Deep in the shady sadness of a vale,
> Far sunken from the healthy breath of morn,
> Far from the fiery noon and eve's one star,
> Sat gray-haired Saturn, quiet as a stone,
> Still as the silence round about his lair.

The seventh day of the week takes its name from Saturn, *Saturni dies;* in French, *Samedi.*

The astrologers found reasons satisfactory to them for making Saturn the exact opposite of Jupiter, calling him the "Greater Infortune," while Jupiter was the "Greater Fortune." Malefic though he be, according to their system, nevertheless they ascribed many admirable qualities to Saturn, which he was capable of imparting to those born under his rule when he was "well dignified." "He is profound in imagination," says Lilly, "in his acts severe, in words reserved, in speaking and giving very spare, in labor patient, in arguing or disputing grave, in obtaining the goods of this life studious and solicitous, in all manner of actions austere." This is a very good description of what is popularly known as a saturnine disposition. But when Saturn is plagued with evil influences, then the astrologers give him a very bad character. He is "envious, covetous, jealous, mistrustful, timorous, sordid, dissembling, sluggish, stubborn, a contemner of women and a liar, never contented and ever repining." Some of these, too, are good definitions of what we call a saturnine person, and the adoption of the word in common use shows how deeply the astrological superstition sank into people's minds in former centuries.

Saturn's mean distance from the sun is 886,000,000 miles. His period of revolution, or the length of his year, is twenty-nine and one-half years, consequently he remains visible in the same quarter of the sky for several years in succession. He comes into opposition to the sun once in every 378 days. From the earth

Saturn's distance varies between 1,028,000,000 and 744,000,000 miles.

The globe of Saturn measures 75,000 miles through the equator and 68,000 miles through the poles. The difference is equal to the entire diameter of the earth. His volume is 760 times that of the earth, but his density is so slight that he equals only 95 earths in weight. Saturn would float if there were an ocean big enough to hold him, his mean density being only five-sevenths that of water. His axial rotation period is about the same as that of Jupiter—10 hours 14 minutes.

The great marvel of Saturn is his rings, of which Professor Young has said that they are "unlike anything else in the universe," and are "the most beautiful and most interesting of all telescopic objects." Besides these rings, which are suspended directly over his equator, and are divided by two gaps, Saturn has ten moons, two of which are very minute objects, only recently discovered. The outer diameter of the ring system is no less than 168,000 miles, and yet the rings probably do not exceed 100 miles in thickness. It has been established, both by mathematical reasoning and by spectroscopic evidence, that they consist of an almost infinite number of small bodies, like flights of meteors, revolving around Saturn in a common plane. Their telescopic appearance changes according to the inclination of their plane towards the earth. When the inclination is greatest, the rings appear in an oval form, extending a little beyond the poles of the planet; when they are edgewise towards the earth, they practically disappear, all that is left in sight with telescopes being a delicate straight line

of light which resembles a pair of illuminated needles stuck into the ball of the planet on opposite sides. They thus disappear once in about every fifteen years. The latest disappearance occurred in 1907. About 1915 they will be opened again to their widest extent.

Galileo discovered the existence of the rings of Saturn in 1610. As in the case of his discovery of the phases of Venus, he concealed the fact for a time in an anagram sent to Kepler. In 1612 they got so near edgewise that he could no longer see them, and his amazement for a time was extreme, while his enemies laughed at him and gloried in his disappointment and what they regarded as deception. In 1616 he caught sight of them again, but, becoming blind in his later years, he never recognized them in their true form, always supposing that they were subsidiary bodies attending Saturn, or projections extending out on each side of the globe. It was not until 1656 that Huygens finally saw the rings in their true form. It is a curious fact, to which Proctor was the first to call general attention, that among the discoveries of Layard in the ruins of Nineveh was a figure of the god Nisroch (identical with Saturn) enveloped with a ring. Mr. Proctor thought that here might be an indication that the ancient Chaldean astronomers had telescopes, but no confirmation of this has been obtained.

What has been said about the habitability of Jupiter applies equally to Saturn. His globe, as we have seen, possesses a density much less, even, than that of Jupiter, so that it is hardly possible to suppose that it has a solid nucleus at the centre. If so it must be relatively very small. At the distance of Saturn, too,

the light and heat of the sun are reduced to about one-ninetieth of their intensity at the earth, so that if this planet should ever become a solid globe its surface temperature would be so extremely low that no living forms with which we are acquainted could exist there.

XVIII

THE MOON

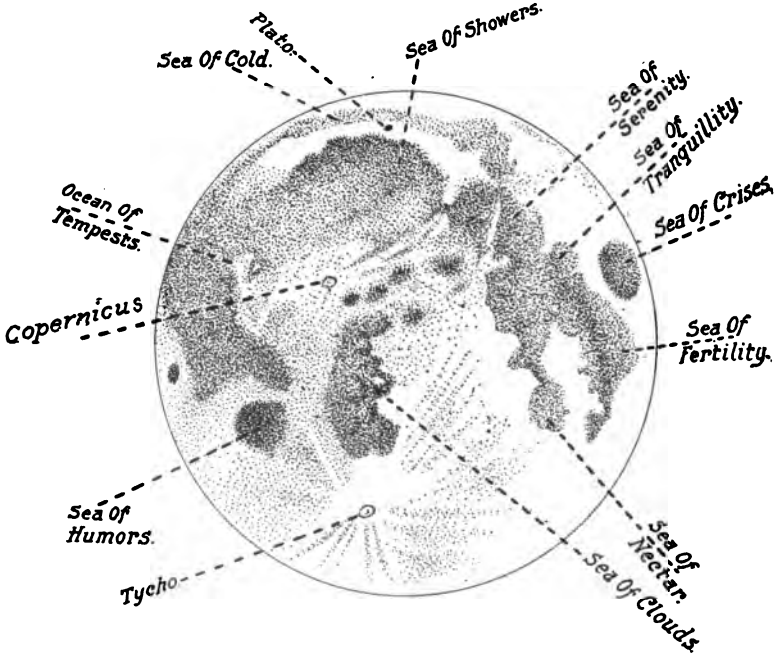
Queen and huntress chaste and fair,
Now the sun is laid to sleep,
Seated in thy silver chair
State in wonted manner keep.
Hesperus entreats thy light
Goddess excellently bright.

—*Ben Jonson.*

THE imagination of mankind has never resisted the fascination of the moon. Under her magic spell the whole world is transformed, and every mind becomes poetical in its degree. Watch the effect upon a great ship's company when the full moon shines over the sea. It may be "the captain's night," with a brilliant ball on the promenade deck, but neither the dancing nor the small talk nor the music can overmatch the attraction of the moon, and couples will be observed withdrawing from the revelry and seeking open places on the deck where they can watch the wondrous sight of Diana on her throne.

Without the presence of the moon the Grand Canal of Venice fails in its sorcery. The Parisians eagerly await the nights of the *clair de lune* to assemble along the banks of the Seine and enjoy the spectacle of their beautiful and historic river stretching its shin-

Chart XIV



THE MOON AS SEEN WITH THE NAKED EYE.

ing reaches between the bridges, while the towers of Notre Dame stand bewitched in the moonlight. London's Victoria Embankment and ugly Thames become fairy scenes when the rays of the full moon touch them. What New-Yorker who has ever crossed the Brooklyn Bridge at midnight, when the moon was silvering the bay and turning the sails of distant sloops into ebon wings outspread against the brightness, can possibly erase the picture from his memory? The force of the incantation is always and everywhere the same. Who can number the songs and the poems that have been inspired by the moonlight? In the depths of the African or the Amazonian forests, or the wilds of Canada, or among the palm-ringed Pacific islands, or amid the ice and snow of the arctic and the antarctic circles, the moon is the same enchantress.

In every part of the world people have sat in the moonlight, and still sit, spinning fancies about the curious spots on that bright, round face in the sky. The legend of the Man in the Moon is as ancient and as multiform in its variations as anything in the history of human thought. In China the Man in the Moon is believed to govern marriages and to tie together with an invisible silken cord the young men and maidens whom he designs to unite in matrimony. "This," says the Reverend Timothy Harley, commenting on the story in his *Moon Lore*, "must be the man of the *honey-moon*, and we shall not meet his superior in any part of the world." In Teutonic legend the Man in the Moon, carrying a bundle of sticks on his back, represents a Sabbath-breaker who met a divine being while cutting wood on the sacred day, and

when remonstrated with laughed and said that Sunday and Monday were all the same to him. "Then stand in the moon for a perpetual Monday!" (Moonday) was the sentence instantly pronounced. Dante says that the Man in the Moon is Cain. Some of our Indian tribes had a legend that the Man in the Moon was a hunter with his dog, banished to the sky for some transgression; and a British Columbian tribe, visited by Mr. William Duncan, told him a story of a child that cried out in the night for water, but was neglected by its mother, whereupon the Moon suddenly appeared at the door of the lodge with a pot of water which the child eagerly seized. Then the Moon carried the child up into the sky, where its face can still be seen. The New Zealand savages said that the Man in the Moon was one who, going out in the night, stumbled and sprained his ankle, whereupon he cried for help, and lamented so loudly that at last the Moon came down and took hold of him. In his terror he seized a bush, but the Moon pulled it up by the roots and sailed back into the sky with both man and bush.

The Woman in the Moon has also been a favorite subject of myth-making. In truth, it would seem that the profile of a woman's face in the moon is more evident than any masculine eidolon there. It can be seen at any time between first quarter and full moon. The face, which is bright, is turned eastward. The outlines of forehead, nose, mouth, and chin are formed by the "Sea of Showers" and the "Sea of Clouds"; the eye is indicated by one of the small, dark, oval plains near the centre of the disk, while

the "Seas" of "Serenity," "Tranquillity," "Fertility," and "Nectar" constitute the hair on the top and back of the head. The great crater ring Tycho blazes like a jewel on her bosom. The Chinese call the Woman in the Moon the Fairy Queen, and imagine that they can see her palace. Even the Esquimaux have invented a legend about her, although their story relates rather to the moon's phases than to anything visible on her face. They say that the Sun and the Moon are brother and sister, and that the Sun, in a fit of anger, burned one side of his sister's face coal black. Then she ran away, and the Sun has been chasing her ever since. When the burned side of her face is towards us, she disappears. Professor Charles Frederick Hartt, the geologist, found a variant of this legend among the tribes along the Amazon. The Samoan savages say that the Moon came down one evening and stole a woman named Sina while she was at work in the twilight. Sina has never been able to get back again, but she still has her mallet and the board on which she was beating out bark to make cloth. The most charming of all the moon legends is that of the Greeks, who called the moon Selene, and said that she fell in love with the beautiful youth Endymion as he lay asleep on a mountain in Elis.

> Peace ho! the moon sleeps with Endymion,
> And would not be awaked.
>
> —*Merchant of Venice.*

Mr. Harley calls attention to the fact that in English, French, Italian, Latin, and Greek the moon

is feminine, but in the Teutonic languages masculine.

Equally famous with the Man in the Moon and the Woman in the Moon is the Hare in the Moon. The original of this is a Buddhist legend. The god Sakkria, disguised as a Brahman, pretended to be starving and went to the animals for help. The monkey got him a bunch of mangoes; the coot picked up a fisherman's neglected string for him; the fox stole him a pot of milk. At last the god approached the hare. "I have nothing but grass," said the hare, "and you can't eat that." "But your flesh is good," suggested the pretended Brahman. The hare assented. "Then," said the Brahman, "I'll kindle a fire at the foot of this rock and you jump off into it. That 'll save me the trouble of killing you." The hare assented again, but as he leaped from the rock the god caught him in his arms, and then drew his figure in the Moon as a perpetual reminder of the excellence of self-sacrifice.

The worship of the moon extends to the most ancient dates of history. In Chaldea the principal centre of moon-worship was Ur, in the land of Abraham. The Israelites, in their pagan age, adored the moon under the Assyrian name of Astarte or Ashtaroth. Some have asserted that Mount Sinai was originally consecrated to the moon. The moon was the greatest divinity of the Arabs. She was one of the gods of the Persians. The moon played a great part in the religion of India, and in China moon-worship still exists. In ancient Egypt she was Isis, the sun being Osiris. The Greeks first worshipped her under the

names of Selene and Phœbe, the name Artemis (Diana), as Sir G. C. Lewis thinks, being of later date. Diana and Luna were the Roman names for the moon-goddess. The moon played a conspicuous part in the rites of the Druids, and there are traces of ancient moon-worship in popular customs still surviving in the British Isles, as well as in many parts of Europe. Among the American Indians moon-worship was widely spread. By the Aztecs she was deified under the name Meztli, and they had a Pyramid of the Moon, as well as one of the sun. In the Temple of the Sun at Cuzco was a chapel consecrated to the moon, the deity held next in reverence to the sun and regarded as the mother of the Incas, the moon being both the sister and the wife of the sun.

In astrology the moon, of course, makes a great figure, and as she passes so rapidly through the signs of the zodiac her influence upon the planets is described as very variable. When "well affected" she bestows good qualities, according to Lilly, but even at the best a "moon person" is apt to be unsteady and inclined to flit about. When she is "ill affected" the moon makes bad characters. As Venus is said to bestow dimples, so the moon, it is averred, usually makes "one eye a little larger than the other" in her subjects.

The strange spots on the moon, that have given rise to so many legends, first had their true character revealed when Galileo, in 1610, aimed his telescope at her. They turned out to be mountains, hills, and plains. "It is just like the earth," he declared. But the assertion, often made, that Galileo believed the

moon to be inhabited is erroneous. In a letter written in 1616, and quoted by Mr. Fahie in his *Life*, Galileo distinctly states his belief that it is impossible for the moon to be inhabited, and he gives substantially the same reasons that would be given to-day—*viz.*, the absence of water and the lack of rapid succession of day and night on her surface. The sunlight takes two weeks to creep over the face of the moon, and day and night there are each a fortnight in length. Moreover, as we now know, there is virtually no air on the moon. Yet the moon is "of the earth, earthy." When Addison wrote:

> Soon as the evening shades prevail
> The moon takes up the wondrous tale,
> And nightly to the listening earth
> Proclaims the story of her birth,

he did not in the least suspect what the story was that the moon so insistently repeated. It was left for Professor George Darwin and mathematical physics to unfold that story, which is one of the most wonderful in the whole domain of astronomy. Put into a few words, this story avers that the moon is the child of the earth, born by violence, under the stress of forces generated by a rapid rotation of the original single viscid mass, combined with tidal action emanating from the sun. In the constellation Vulpecula there is a nebula which shows a similar process of division now going on. Two enormous masses are seen in apparent swift rotation, while their whole substance has been whirled out into an hour-glass or dumb-bell shape. After the separation was once

effected, the moon retired from the earth under the effects of "tidal friction," a subject too technical to be discussed here. But if she carried air and water with her when she parted from her mother earth, what has become of them? According to one opinion, they have been absorbed into her rocks as she cooled off. The relics of frightful volcanic activity on the moon seem conclusive evidence that there was once water and fire there. According to another opinion, the slight mass of the moon (one-eightieth that of the earth) prevented her from permanently retaining the gaseous and volatile elements. Whatever the cause, the fact remains that no bodies of water, and no atmosphere resembling ours, exist today on the moon. Yet her great plains strikingly resemble the beds of dried-up oceans.

As a telescopic object the moon takes the first rank. The slightest magnification begins to reveal the marvellous picturesqueness of her broken landscapes, and with higher powers the spectacles that she presents are indescribable in their weird magnificence. Although she is only 2100 miles in diameter, her mountains, and particularly her "craters," are mightier than those of the earth.

Everybody knows, of course, why the moon changes shape as she travels around the earth. These phases are simply due to the change in the extent of the sun-illuminated surface visible to us. When she is between the sun and the earth, she disappears; when she emerges on the east of the sun, she appears as a thin crescent in the western sky, only a narrow rim of the illuminated half being then visible to us; when

she reaches a point at right angles to the direction of the sun, half of the illuminated side appears; when she is opposite to the sun she assumes the full phase, because then the whole of her illuminated side is towards the earth. As she goes round she always keeps the same side towards us, so that we know nothing, except by inference, of the other side of the moon. This peculiarity of the moon's rotation is believed to be due to the braking action of the tides raised by the attraction of the earth when the moon was yet in a viscid state.

The moon both causes and suffers eclipses. When she passes exactly between the earth and the sun, the latter is hidden behind her opaque globe, and we have a solar eclipse—one of the most interesting of all astronomical phenomena, on account of the marvellous streamers of light, called the corona, which then appear surrounding the eclipsed sun, and extending away, in some cases, millions of miles. When the moon passes the earth on the side opposite to the sun—in other words, when she is a full moon—she comes at certain times almost exactly in line with the two, and then she enters the shadow of the earth and is herself eclipsed. Eclipses of the sun are very rare phenomena at any particular place on the earth, because the moon's shadow is reduced almost to a point before it reaches the earth, from her average distance of 239,000 miles, and it is only within the shadow that the sun appears eclipsed. The orbit of the moon around the earth is continually shifting its place a little, and so the point of her shadow does not reach the earth at the same place in successive

eclipses. Eclipses of the moon are more frequently seen, because the earth's shadow, being much larger than the moon's, completely buries the latter when she passes into it, so that the moon can then be seen eclipsed from all places on the earth above whose horizon she happens to be at the moment.

An eclipse of the moon is very interesting to watch, because of the curious reddish tint which the face of the moon usually assumes when she is within the earth's shadow. This is due to the refraction of light by our atmosphere around the edge of the globe; and this light, being bent into the shadow, reaches the moon, and produces a partial illumination there. It follows that if we could be upon the moon during such an eclipse we should see the huge black globe of the earth completely covering the sun and surrounded with a brilliant ring of reddish light. At times when the atmosphere of the earth is choked with clouds, the moon almost disappears during an eclipse, because then the refraction is prevented by the clouds.

The primary reason why there is not an eclipse of the sun at every new moon, and an eclipse of the moon at every full moon, is because the moon's orbit is inclined to the plane of the ecliptic, and ordinarily she passes above or below the sun in the one case, and above or below the conical shadow of the earth in the other case. The greatest number of eclipses that can occur in a year is seven, five of the sun and two of the moon; the least number is two, both of the sun. On the average four or five eclipses occur every year, more of the sun than of the moon, but, as already

explained, eclipses of the sun are visible from only very limited areas on the earth, and the path of the shadow seldom falls in a convenient place for observation. Some solar eclipses are annular — *i. e.*, they occur at times when the moon is in the more distant part of her orbit, and the point of her shadow falls short of the earth. Then a bright rim of the solar disk appears surrounding the black globe of the moon. Total eclipses of the sun appear as partial eclipses to those who are situated within about two thousand miles of the edge of the moon's shadow. So, too, the moon may be partially eclipsed by passing through the edge of the earth's shadow.

Eclipses have played an astonishing part in history. The total obscuration of the sun in broad day is a phenomenon especially calculated to awaken superstitious terror, and accordingly we find that solar eclipses have generally been regarded with more fear and awe than lunar ones. It is not too much to say that, in the ages when the movements of the celestial bodies were not understood, the course of the history of nations was sometimes changed by the passage of the moon across the sun's face. Battles were stopped, the march of armies was arrested, treaties were dictated by the terror inspired by an unexpected eclipse. Since eclipses are phenomena that can be predicted with almost absolute exactitude centuries in advance, it is easy, from our knowledge of the moon's motion, to trace her course backward as well as forward, and thus eclipses occurring thousands of years ago, and recorded by the uncritical analysts of those times, have enabled modern astronomers to fix disputed

dates in history. Herodotus records the fact that a battle between the Medes and Lydians was interrupted by an eclipse of the sun. Calculation shows that this eclipse must have occurred on May 28th in the year 585 B.C.

A curious point in the history of the celebrated Five Nations, occupying central New York at the time of the arrival of the white men, is connected with an eclipse. These Indians had a tradition that a great war between the Mohawks and the Senecas was averted by the interposition of Heaven. Some young Seneca warriors, bent on winning fame for themselves, went, in a time of peace, into the land of the Mohawks and made captive a number of girls who were at work in the cornfields. The captives were taken to Canandaigua. Their arrival caused consternation among the Senecas, whose chiefs knew well the terrible vengeance that the Mohawks would exact. Still, the Senecas also were a proud people, and when swift runners arrived demanding a humiliating submission, the Senecas responded with open defiance, and resolved to meet the Mohawks in battle. A host of Mohawk warriors, thirsting for vengeance, hurried on the forest trails to Canandaigua, and the hostile ranks were about to close in deadly contest when one of the Mohawk girls cried out:

"See! the Great Spirit is angry!"

She pointed to the sky, and, all eyes following hers, they saw the sun in heaven beginning to darken. Swiftly its light was withdrawn and night fell upon the lake and the forest. The warriors of both tribes dropped to their knees, and then an aged sachem of

the Senecas called for the peace-pipe. As it passed from lip to lip, the darkness lightened, the sun slowly reappeared, and in a short time his smiling face was again bent down upon his red children. The captives were surrendered, reparation was made, and the Mohawks, with full quivers, marched back to their valley home. The late Professor Lewis Swift showed that a total eclipse of the sun was visible in central and western New York on June 28, 1451, and this fact has been regarded as affirming the historic accuracy of the Indian tradition, as well as fixing a date for the event.

On the other hand, lunar eclipses sometimes caused great terror. Plutarch, in his *Life of Nicias*, has a curious story in point. When the Athenian army, baffled before Syracuse, was about to embark for home, there happened an eclipse of the moon, "at which," says Plutarch, "Nicias and all the rest were struck with a great panic, either through ignorance or superstition. As for an eclipse of the sun, which happens at the conjunction, even the common people had some idea of its being caused by the interposition of the moon. But they could not easily form a conception by the interposition of what body the moon, when at the full, should lose her light and assume such a variety of colors. They looked upon it, therefore, as a strange and preternatural phenomenon, a sign by which the gods announced some great calamity."

The reader will observe that even in their terror the frightened soldiers did not fail to note the curious coloration of the eclipsed moon, due, as we now

know, to the refraction of light by the earth's atmosphere.

But eclipses were not universally considered by the ancients as miraculous events. Better instructed minds perceived that there was a regular recurrence of these phenomena, and that they were connected with the movements of the moon. Thales is said to have predicted the solar eclipse of 585 B.C., and Hipparchus ascertained the general law of the moon's motions. Even the Chaldeans knew that eclipses recur in a certain order during every successive period of eighteen years, and to this period was given the name Saros.

The revolution of the moon naturally gave rise to the division of time into months. All would have been very simple if the moon's time of revolution had been an exact fraction of the year. Then every year would have had precisely twelve lunar months. But the time from one new moon to the next is about twenty-nine and a half days, and the problem that the calendar-makers had to solve was how to adjust this so as to give a fixed number of months to the year. This is not the place to enter into a discussion of the difficult subject of the settling of the calendar, which is dealt with in ordinary school-books of astronomy, but it may be remarked that as a result of the necessary adjustments new and full moons may occur at any time in the course of our present months. So the name month (undoubtedly derived from the same root as moon, just as the original idea of a month was suggested by the moon's period of revolution) no longer possesses more than a historic

connection with the monthly traveller through the sky.

Another, and practically a much more important, relation of the moon to the earth is seen in the tides. Both the sun and the moon raise tides in the ocean, but those of the moon are much the higher, simply because she is so near. This is a technical subject beyond the intended scope of our book, but it is interesting to remember that but for the tides produced by the moon some of the most important harbors on the earth would be shut against deep-draught ships.

Those who look at the new moon often see the whole face of her globe faintly illuminated, the bright crescent seeming to border it like a silver handle. Even some of the ancients recognized the fact that this light comes from the earth. At such times the earth hangs in the lunar sky as a round, gleaming ball of portentous size, many times larger than the full moon looks to us, and the faint illumination that we see on the part of the moon hidden from the sun is earth light.

In her course through the zodiac—for the moon follows, practically, the same path as the planets—she often passes over, or occults, stars, and occasionally planets. These phenomena are interesting to observe with the naked eye, if the star occulted happens to be a bright one. If the occultation occurs near the time of new moon, or first quarter, the star disappears behind the dark part of the moon as if it had been snuffed out. When the moon is crescent-shaped the star, just before its disappearance, often looks as if it were *inside* the horns of the moon, and this appear-

ance is so deceptive that some people think that the moon really can carry a star in her arms. The monthly progress of the moon through the zodiacal constellations, and her conjunctions with the planets and the first and second magnitude stars, or with clusters like the Pleiades and the Hyades, are among the most captivating sights that astronomy with the naked eye has to offer.

The idea that the moon exercises an important influence on the weather has no scientific foundation, all attempts to establish such an influence having failed. So, too, the supposed influence of the moon on the sap in trees, and on the growth of plants has no basis except that of a wide-spread popular belief.

INDEX

ACHERNAR, 38, 168.
Achilles likened to Sirius, 42.
Al Aaraaf, 147.
Al Bali, 131.
Albireo, 127.
Al Chiba, 77.
Alcor, 69.
Alcyone, 23.
Aldebaran, 8, 11, 21, 22.
Alderamin, 136.
Alfirk, 136.
Algenib, 133, 153.
Algieda, 122.
Algol, 152.
Alioth, 71.
Al Jauzah, 36.
Allen, Richard Hinckley, 17, 22, 26, 28, 36, 38, 41, 46, 65, 71, 73, 78, 80, 108, 163.
Almaak, 141.
Alphacca, 93.
Alpha Centauri, 165.
Alpha Draconis, 98.
Alphard, 62.
Alpheratz, 133, 141.
Al Rischa, 139.
Altair, 115.
Amazon Star, the, 32.
Andromeda, 3, 4, 141; mythology of, 142; telescopic objects, 145.
Antares, 8, 11, 102, 104.
Antinoûs, 115.
Aquarius, 130; mythology of, 131.
Aquila, 115; mythology of, 116; telescopic objects, 117.
Ara, 166.
Aratus, 3.
Arctic constellation, 2.
Arcturus, 7, 90, 91.
Argo Navis, 158.
Ariadne's Crown, 94.
Ariadne's Hair, 84.
Aries, 148; mythology of, 148; telescopic objects, 150.
Arion, legend of, 125.
Atlas, 23, 28.
Arthur's Wain, 70.
Aselli, 57.
Asterion, 85.
Asterope, 23, 28.
Astræa, 80.
Auriga, 18; mythology of, 19; telescopic objects, 20.

BEAR DRIVER, 90.
Beehive, the, 60.
Bellatrix, 32, 33.
Belt, Orion's, 24, 31, 33.
Benetnasch, 71.
Berenice's Hair, 7.
Betelgeuse, 11, 30, 32.
Bird, Great Storm, 78.
Bird, the Red, 78.
Boötes, 2, 89; mentioned by Homer, 89; mythology of, 92; telescopic objects, 92.

CAMELOPARDALIS, 20.
Cancer, 57; mythology of, 60; telescopic objects, 61.
Canes Venatici, 85.
Canis Major, 42; mythology of, 46; telescopic objects, 47.

Canis Minor, 48; telescopic objects, 50.
Canopus, 46, 159, 161.
Capella, 11, 18.
Caph, 146.
Capricornus, 122; mythology of, 123; telescopic objects, 124.
Carlyle, Thomas, on Canopus, 160.
Cassiopeia, 145; seen at Mycenæ, 3; telescopic objects, 147.
Castor, 50, 53.
Celæno, 28.
Centaurus, 164.
Cepheus, 135; mythology of, 136; telescopic objects, 136.
Cetus, 155; mythology of, 156; telescopic objects, 157.
Chara, 85.
Charioteer, the, 18.
Charles's Wain, 69, 70.
Chi Persei, 153.
Coal Sack, the, 176.
Colas, J. A., 34.
Columba, 41.
Coma Berenices, 83; telescopic objects, 84.
Constellations, seen from Mount Etna, 5; and the seasons, 6.
Cor Caroli, 85.
Cor Hydræ, 62.
Corn Mother, the, 80.
Corona Borealis, 93; mythology of, 94; telescopic objects, 94.
Coronis, story of, 78.
Corvus, 77.
Cor Serpentis, 106.
Crater 75.
Cursa 38.
Cygnus, 127; telescopic objects, 129; star "61," 128.
Cynosura, 96.

DABIH, 122.
Dancing Bears, the, 72.
Delphinus, 124; telescopic objects, 125.
Delta Libræ, 89.
Deluge and the Pleiades, 27.
Deneb, 127.
Deneb Kaitos, 155.
Denebola, 66.
Diamond of Virgo, 79.
Donati's comet and Arcturus, 91.
Draco, 98; mythology of, 100; telescopic objects, 101.
Druids, cult of Pleiades, 27.
Dubhe, 71.

EAGLE of the winds, 115.
Electra, 23, 28.
El Nath, 18, 24.
Equuleus, 125.
Eridanus, 37; mythology of, 38; telescopic objects, 39; southern, 168.
Erigone, 81.
Eta Argus, 160.
Europa, myth of, 25, 26.

FRIGID MAIDEN, the, 79.
Fomalhaut, 131.

GAMMA DRACONIS, 99, 100.
Garnet Star, Herschel's, 137.
Gate of the Gods, 123.
Gemma, 93.
Gemini, 50; mythology of, 52; telescopic objects, 55.
Golconda of the heavens, 30.
Golden Age, the, 80.
Golden Fleece, the, 100, 101.
Golden Ox, the, 26.
Gomeiza, 49.
Great Dipper, the, 69.
Great Square of Pegasus, 132.
Greenwich of the sky, 138.
Grus, 167.

HARMONY in the heavens, 13.
Head of Draco, 99.
Head of Orion, 34.
Helice, 72, 96.
Hercules, 107; mythology of, 108; telescopic objects, 110; great cluster in, 110; motion towards, 109.

Hood, Dr. Thomas, 73.
Hydra, 6, 61; mythology of, 62.

JASON, 5, 100, 101.
Job, reference to Pleiades, 23; to Arcturus, 90.
Job's Coffin, 124.
Jupiter, 216; various names of, 216; astrology of, 216; distance and appearance, 217; oppositions of, 217; moons of, 218; Galileo's discoveries, 218; density of, 219; clouds on, 219; habitability of, 219; Red Spot on, 220; gravity on, 221.

KARNAK, temple of, 100.
Kern Baby, the, 80.
Kochab, 95.

LACERTA, 135.
Laconian Key, the, 146.
Landmarks, stars as, 1.
Lantern Feast and Pleiades, 27.
Leo, 65; mythology, 67; telescopic objects, 68.
Leo Minor, 68.
Lepus, 40.
Lewis, Sir G. C., 23, 72.
Libra, 87; mythology of, 88.
Lilac stars, 84.
Little Dipper, the, 95.
Lynx, 55.
Lyra, 118; mythology of, 120; telescopic objects, 120.

MAGELLANIC CLOUDS, 2, 169.
Magnitudes, stellar, 10.
Magi, star of the, 84, 140.
Magpie Bridge, the, 116.
Maia, 23.
Manger, the 57.
Mars, 209; various names of, 210; astrology of, 210; oppositions of, 211; gravity on, 212; polar caps of, 212; atmosphere of, 212; "canals" on, 213; irrigation of, 214; giants on, 215; moons of, 215.
Markab, 133.
Mazzaroth, 44.
Medusa, 4, 152.
Megrez, 71.
Menkalina, 18.
Menkar, 155.
Merak, 71.
Mercury, 192; astrology of, 193; and naked eye, 195; transits of, 197; density of, 197; life on, 198; rotation of, 199; temperature on, 200.
Meridian, definition of, 16.
Merope, 23, 28.
Mesarthim, 150.
Milk Dipper, the, 112.
Milky Way, the, 171; Galileo on, 172; shape of, 173; constellations, 174; details of, 175; stars near, 178; distance of, 179; mythology of, 179.
Mira (o Ceti), 156.
Mirach, 141.
Mirzam, 45.
Mizar, 69.
Monoceros, 48.
Moon, the, fancies about man in, 227; fancies about woman in, 228; the hare in, 230; worship of, 230; gender of 230; origin of, 232; eclipses, 234, *et seq.*; phases of, 233; superstitions about eclipses, 237, 238; and the months, 239; and the tides, 240; earthlight on, 240; occultations by, 240; and weather, 241; and plants, 241.
Music of the Spheres, 191.

NAMES of constellations, 3.
Nebula, in Orion, 34; the Whirlpool, 86; Dumb-bell, 126; Andromeda, 142; the Ring, 120; the Key-hole, 161.
Nebulæ, Field of the, 82.
Nimrod, 36.
Northern Cross, 7, 127.

North Star, the, 95.

Octant, 161.
Onondaga Indians and Pleiades, 12, 26.
Ophiuchus, 105; mythology of, 105; telescopic objects, 106.
Orihimé (*see* Spinning Damsel), 116, 181.
Orion, 2, 3, 7, 30; origin of, 31; mythology of, 35; telescopic objects, 36.

Pegasus, 132; mythology of, 133; telescopic objects, 135.
Perseus, 3, 4, 143, 151; new star in, 152; telescopic objects, 154.
Phaed, 71.
Phaet, 41.
Phæton, 39.
Phœnice, 95.
Phœnix, 167.
Pisces, 138; mythology of, 139; telescopic objects, 140.
Piscis Australis, 131.
Planets, the, 186; how to find, 189.
Pleiad, the Lost, 23, 28.
Pleiades, 21, 23; photographs of, 24.
Pleione, 28.
Plough, the, 69.
Pointers, the, 71.
Polaris, 95; and the slaves, 96.
Pole, position of true, 146; southern, 161.
Pollux, 50, 53.
Præsepe, 57.
Prince of the Zodiac, 149.
Procyon, 11, 48.
Prosper Henry, 11.
Pyramid, the Great, 27, 99.

Ras Algethi, 109.
Ras Alhague, 105.
Regulus, 65.
Rigel, 30, 32, 38.
Ring Nebula, 180.
Royal Stars, the, 66.
Ruchbar, 146.

Sadalmelik, 131.
Sadalsuud, 131.
Sagitta, 117.
Sagittarius, 112; star clusters in, 112; mythology of, 113; telescopic objects, 114.
St. Paul, 53.
Saturn, 221; astrology of, 222; density of, 223; rings of, 223; Galileo's discoveries, 224; habitability of, 224; possible knowledge of, at Nineveh, 224.
Scheat, 131, 133.
Schedar, 146.
Scorpio, 102; mythology of, 103; telescopic objects, 104.
Scutum Sobieskii, 114.
Seiss, Rev. Joseph A., his "gospel mythology," 20, 29, 36, 39, 40, 46, 54, 63, 67, 73, 76, 78, 82, 89, 98, 101, 104, 109, 117, 124, 131, 149, 154, 156.
Septentriones, the, 71.
Serpens, 105; mythology of, 106; telescopic objects, 106.
Seven Little Indians, 70.
Seven Stars, the, 71.
Sextans, 74.
Sickle, the, 65.
Sirius, 3, 9, 11, 42, 47, 88; size of, 44; crossed Milky Way, 43.
Southern Cross, 2, 162.
Spica, 7, 11, 78.
Spinning Damsel, the, 116.
Stars, as sentinels, 1; personal influence of, 2; and seasons, 7; individuality of, 9; colors of, 11; grouping of, 11; harmonious effect of, 12.
Sword of Orion, 34.

Tanabata, festival of, 116.
Taurus, 21; mythology of, 25; telescopic objects, 30.
Taygeta, 23, 28.
Tennyson on Pleiades, 24.

Thor's Wagon, 73.
Three Guides, the, 133.
Thuban, 98.
Toucan, 167.
Triangle, the, 166.
Triangulum, 150.
Twins, the sailors' stars, 54.
Tycho Brahe's star, 146.

UNUKALHAI, 106.
Ursa Major, 69; mythology of, 72; telescopic objects, 74.
Ursa Minor, 95; mythology of, 97; telescopic objects, 98.

"V," the letter, 21, 22.
Vega, 11, 118, 119, 120.
Venus, 201; astrology of, 203; Galileo's discoveries, 204; transits of, 205; habitability of, 206; atmosphere of, 206; temperature on, 206; surface features of, 207; appearance of earth from, 208; upright axis of, 209.
Vindemiatrix, 80.
Virgo, 7, 78; mythology, of 80; telescopic objects, 82.
Vulpecula, 126.

"W," the letter, 145.
Water-bearer, the, 130.
White Ox, the, 170.
White Tiger, the, 26.

"X" CLASS, Professor Newcomb's, 159.
Xavier de Maistre, remark about stars, 12.

ZODIAC, the, 138.
Zodiacal Light, the, 182.
Zubenelgenubi, 88.
Zubeneschemali, 88.

THE END

3 2044 074 410 432

This
be returned to
on or before the last dat
a day is incurred
the specified

3 2044 0